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New mainstream SSD breaks Lab records!
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- 256GB SSD vs. two 128GB SSDs
- PCIe 3.0 vs. PCIe 2.0
- Core i5-3570K vs. Core i5-4670K vs. FX-8350

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Bitcoin Illustration by nagdude

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IN THE LAB









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MAXIMUM PC

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Gordon Mah Ung

WHY WE TEST

THE CORE I5-4670K is the fastest all-around midrange CPU. And running AHCI instead of legacy IDE mode is hecka faster on a fast SSD and a Z77 chipset. How do I know? We tested it.

That's not all, either. We also tested whether two midrange GPUs in SLI are faster than a higher-end GPU. And we tell you if a cheap liquid cooler is better than a cheap air cooler. Should you really give a hoot about running your PCIe in Gen 3 mode or paying extra for high-clocked RAM? We tell you that, too.

Why did we do this testavaganza? Because testing is the very essence of being a PC enthusiast.

We're not the kind of crowd that's going to be told that something is X faster or Y better than something else and take it on faith. No. If a company makes an extravagant marketing claim, we want it backed up by the numbers.

A PC enthusiast could be loyal to Intel or AMD, but should the numbers show that A is better than B, we'll go with A, or at least weigh that performance against other factors. Case in point: We long ago established (through testing) that Thunderbolt is indeed faster than USB 3.0, but if we have a choice between a USB 3.0 or Thunderbolt external drive, we'd probably take the USB 3.0 drive because a fast drive that you can't plug in anywhere isn't very useful.

It's that devotion to the facts, to the numbers, that makes the PC enthusiast so much better than the technology fanboy. Fanboys swear fealty to a brand and then never say peep if they are betrayed by that brand. No, they'd rather just rationalize it and stay in lockstep with that brand in hopes that it'll get better.

The PC enthusiast is better than that.

That's because we let the cold, hard facts take precedence over the marketing hype. If testing shows that the company is full of it, the PC enthusiast won't rationalize it away. He or she will just mark it down in the negative column and regretfully remember the company's transgression the next time it comes to make a purchasing decision.

That is why we test.



Gordon Mah Ung is Maximum PC's deputy editor, senior hardware expert, and all-around muckraker.

↘ submit your questions to: comments@maximumpc.com

THE NEWS

PC Sales Hit Historic Lows

With an unprecedented five straight quarters of a global decline in shipments for HP, Dell, and others, the winds of change begin to stir

THE RECENT PC news is rife with gloom and vast transitions. Intel's profits are down 30 percent, and it's putting its weight behind a low-power mobile chip, Microsoft is pushing mobile connectivity, and AMD's financial struggles continue. Add to that Gartner's recent report that the major desktop PC manufacturers have seen steadily declining sales for over a year, news that Microsoft is giving away Xbox Live subscriptions with Office 365, and the fact that Netflix is dropping Silverlight for HTML5, and the desktop looks like it's being left behind.

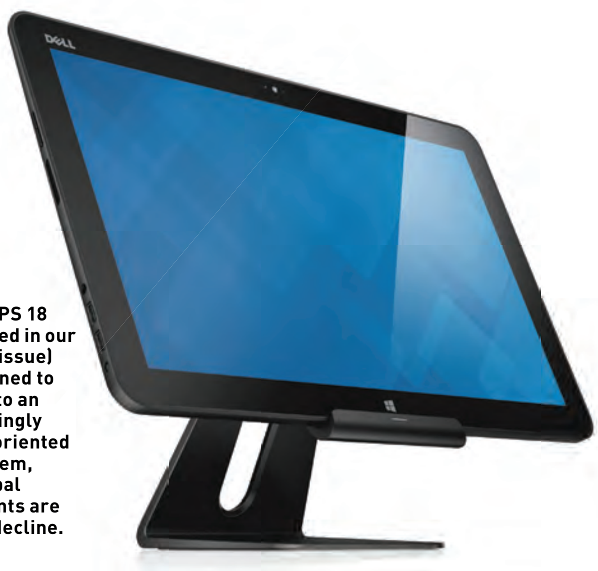
One can think of a number of reasons why. If you just want to check your email, text some people, watch a video, and read some news, you don't need a $1,000 computer for that. You can get a solid tablet for about $250, and smartphones frequently come free with a two-year contract. If you want to game, stores have been putting on fire sales to clear their inventories of PS3s and Xbox 360s, bundling games, controllers, big hard drives, and subscriptions for as little as $200. There's no desktop on planet Earth that can beat that. Plus, Windows 8 does not appear to have driven sales like Windows 7 did.

However, Rob Enderle, president and principal analyst of the Enderle Group, has a different take: "That is an easy conclusion to make, but I think it is wrong. What I think is happening instead is [consumers] aren't replacing the PCs they have. They don't want to learn a new OS, and their existing PC is good enough.... Tablets appear to still be mostly used for consumption and not creation, and iPad sales appear to be shifting to a replacement volume from a penetration volume, which would support the argument that they aren't displacing PCs, they are supplementing them."

Speaking of tablets, Microsoft has been struggling there, as well. It recently took a $900M write-down on unsold inventory of its Surface tablets that use Windows RT, which runs on an ARM-based CPU instead of x86. Meanwhile, its x86-based Surface Pro starts at $1,000, since it packs an Intel Core-i5, 4GB of RAM, a 128GB SSD, and a 1080p 10.6-inch IPS panel. That arsenal prices it above Apple's most expensive iPad, to say nothing of the legion of Android tablets nipping at Apple's heels. One can deduce that the Pro is not flying off the shelves from the fact that Microsoft has been consistently quiet about its sales numbers.

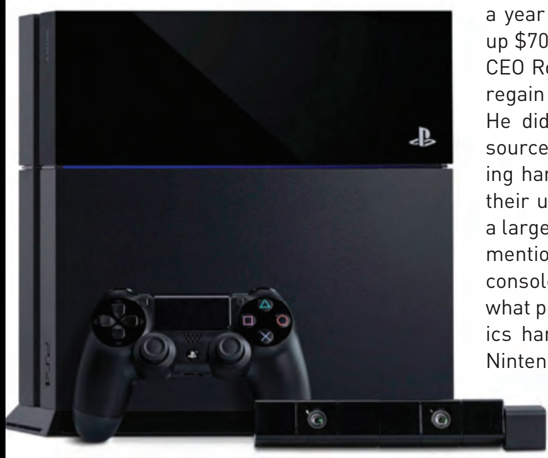
However, you don't need to shield yourself from a falling sky just yet. Intel says that it plans to price its new Atom chip aggressively, putting it in laptops that could cost just a few hundred bucks—albeit probably running Android or Chrome OS instead of Windows. Still, that puts them in direct competition with the tablet class. Enderle chimes in: "As laptops drop into the same price/weight/battery life range [of tablets] late this year and next, we'll see which class falls off, because most of the advantages tablets have will evaporate, while the PC should remain the more capable offering. We'll see, though, as we aren't yet at a steady state." As press time, Intel was also preparing a 4.5-watt Haswell for fanless tablets.

Lastly, Gartner's numbers specific to the United States are not universally bad; Lenovo's shipments were actually up nearly 20 percent from the previous quarter, HP was down just a half of a percent, and Dell was up 6.4 percent. **–Tom McNamara**



Dell's XPS 18 (reviewed in our August issue) is designed to appeal to an increasingly tablet-oriented ecosystem, but global shipments are still in decline.

AMD Posts Loss, Looks to Consoles



AMD reported a $29 million net operating loss on $1.16 billion in revenue in its second quarter, compared to a net gain of $77 million on $1.41 billion in revenue a year ago. However, its net is actually up $70M from the previous quarter, and CEO Rory Read expects the company to regain profitability in the third quarter. He did not elaborate on the expected source of improved revenue, but providing hardware to Sony and Microsoft for their upcoming consoles should deliver a large sum of money; the press release mentions expected income from "game console royalties," but it is not clear what percentage comes from the graphics hardware in current Microsoft and Nintendo consoles. **–PL**

DSL Gets a Gigabit Boost

When providing residential high-speed Internet, servicing the part inside the customer's home is usually the largest expense. A technology from Alcatel-Lucent aims to use existing telephone wiring in the home to achieve speeds competitive with high-grade cable and fiber. Dubbed "G.fast," it uses a combination of technologies: vectoring, which uses a technique like noise cancellation to improve signal quality; pair bonding, which combines multiple copper telephone lines; and phantom mode, which can transfer data between bonded pairs. On the downside, these speeds cannot be maintained on lines longer than 100 meters. The company plans to have the chipset completed by 2015, and retail products in 2016. Huawei Technologies, among others, is also working on its own design. **–TM**



DX11.2 Only in Windows 8.1 and Xbox One

Microsoft said in July that its next update to the DirectX architecture would be exclusive to Windows 8.1 and its upcoming Xbox One console. Version 11.2 includes a function called "tiled resources," which allows a game to use system RAM to seamlessly store textures that do not fit in the video card's dedicated memory. It also offers lower latency. While the "vanilla" version of Windows 8 will not be compatible, 8.1 is a free update. Since the Xbox One is already apparently using a unified memory architecture (in addition to using an x86 CPU), this would make it a lot easier to port the console's games to the desktop operating system. Microsoft's presentation is on YouTube: http://bit.ly/13ZQCSm. **–TM**



Tom Halfhill
Fast Forward

COMPILER TRICKS AND TREATS

IT'S CHEATING only if you get caught. At least, that's what some cheaters think. And sometimes a shortcut looks like a cheat but isn't. Two recent benchmarking controversies provide good examples.

In one case, a popular Android benchmark showed that Intel's latest Atom smartphone processors more than doubled their previous performance, smoking the ARM-based competition. In the other case, ARM processors boosted their performance by 50 percent without even upgrading their hardware.

Engineers are wary of such big leaps and soon found explanations. In both cases, compilers were the culprits. (Compilers are programs that convert a programmer's source-code instructions into the binary code that microprocessors can execute.) One of these cases looks like a trick, but the other could be a treat—under the right circumstances.

In the Android example, the compiler eliminated some benchmark code that measures bit-manipulation performance. This code repeatedly altered the bit patterns in a register, simulating operations common in many real-world programs. The compiler realized it could ignore all but the last instruction in the series by simply writing the final bit pattern into the register. Nice trick! But it defeated the benchmark's purpose and artificially inflated the score.

In the ARM example, the compiler unrolled the loops and inlined the subroutines. I haven't the space to explain these techniques, but they are valid optimizations that boost real-world performance, not just benchmark scores. Nice treats! The problem is that the 50 percent performance increase came at the cost of inflating the program's size by a whopping 40 percent. That code bloat might be acceptable in a roomy PC but is intolerable in the small devices for which those ARM processors are designed.

Lesson: Regard benchmark scores with steely eyes, especially when they suddenly jump. Also, a bunch of different benchmark tests paints a better picture than a single brush.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report.*



Thomas McDonald
Game Theory

THE END OF OWNERSHIP

THE CONTROVERSY over digital rights management (DRM) nearly sank the Xbox One, but it raises questions for gamers that will not go away.

The main problems were: 1) Web-based registration of each game to a single user, which 2) limited transferability of games and 3) required a mandatory copy-protection check-in every 24 hours. This effectively ended the resale and loaning of games, as well as, if I read it correctly, their rental.

This was a fairly obnoxious solution to a new reality of gaming, but Microsoft's failure to concoct an acceptable paradigm for game ownership doesn't mean that new paradigm won't come. It just won't be quite so ham-fisted.

I caught a lot of grief for writing a mild defense of the DRM of Diablo III, which required an always-on Internet connection. Since I use Steam for games almost exclusively, the always-on DRM didn't bother me at all (putting aside the flaw in rollout), and the butthurt outrage of wounded fanboys struck me as one of those privileged First-World moments when people need to get a grip.

The day of "game ownership" may be winding down, and I'm not going to miss it all that much. After three decades of consuming and collecting media, I'm faced with the problem of what to do with it all. There may be a collector somewhere who brushes off that old copy of Ultima Underworld II and fires it up on his vintage 386, but his needs don't drive the industry.

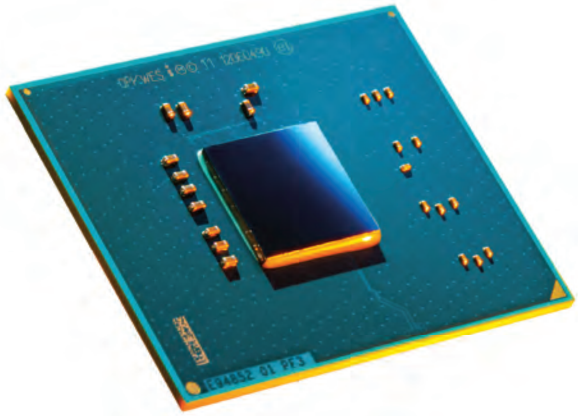
One wall of my house is filled with DVDs and another with games. Know what I do now? Watch Netflix and stream my games from Steam. My wall of ancient media is destined to find a place on a future episode of *Hoarders*.

"Ownership" of media may well fade into history, replaced by rental models and digital downloads. I don't see why we need to fear that.

Thomas L. McDonald is Editor-at-Large of Games Magazine.

BitTorrent Sync Beta Released

Given recent privacy concerns, you may be looking for a secure way to transfer sensitive files over the Internet. BitTorrent Sync entered public beta in late July, accompanied by an Android app. Sync automatically encrypts whatever you send or receive, does not store it in a cloud or re-route it through another network, and sets no limits on the amount of bits you can move. Instead, the computer containing the file(s) you want to sync is basically your cloud. To access your files, you use a "secret," which is basically a randomly generated 32-character password, itself bolstered by 256-bit AES encryption. The program is currently available at http://labs.bittorrent.com, and the mobile app is on Google Play: http://bit.ly/12KDwAZ. **–TM**



Intel's Atom Becomes 'Leading-Edge'

In July, Intel had its first earnings call since CEO Brian Krzanich took over from Paul Otellini. In May, Krzanich made some aggressive strategic changes, introducing a "new devices" business unit and an intention to delve into mobile computing. And during the call, Brian Krzanich talked up Intel's Atom series of CPUs, saying that the company would move the chips up to its "leading-edge process technology." The original Atom launched in 2008 was a relatively humble stepping stone whose popularity took Intel by surprise. The new version sports dual cores, higher clock speeds, and dynamic order execution. **–TM**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

EA
Famously disliked publisher says it will redesign its Origin software, focus on gamers more.

VALVE SOFTWARE
Its annual Steam Summer Sale once again captivated gamers' hearts, minds, and wallets.

AMD
It might not match Intel in sheer horsepower but it still got to 5GHz first with its FX-9590 CPU.

TRAGEDIES

MICROSOFT
Drops the Surface RT price by $150, and then takes a $900 million write-down on unsold units. Swan song?

NVIDIA
Finally settles class action lawsuit in Canada for defective GPUs; will pay $2 million in compensation.

GOOGLE
First Google Glass POV porn hits the web despite its best efforts to keep the project porn-less. Good luck with that!



Quinn Norton
Byte Rights

UPSIDE-DOWN COPYRIGHT

WHAT IF WE'RE DOING this copyright thing all wrong? Well, we obviously are, but what if we acknowledged that fact? What if we acknowledged that copyright as it stands doesn't make anyone happy or make the world a better place or actually reflect how people really behave? What if we, as New Zealand Judge David Harvey has suggested, throw out the basis and rebuild copyright on something that makes sense?

Copyright started out well. When it was invented in 1710 in England, it was an appropriate answer to the problems of that country's social and technical world. A couple of things have changed since then, but the fundamental legal theory of copyright isn't one of them. So, how do we update 300-year-old copyright? Judge Harvey suggests basing it on Article 19 of the Declaration of Human Rights, which reads in part: "Everyone has the right to freedom of opinion and expression... to seek, receive and impart information and ideas through any media..."

Right now, copyright is a monopoly property with a few exceptions for expression. Harvey suggests turning this around, that copyright shouldn't be property, but an exception to the human right to expression and information. It doesn't mean anyone could do anything they want with copyrighted material, but that normal digital use and sharing wouldn't be criminalized anymore.

Making copyright an exception to speech is brilliant. It no longer makes sense to contract an infinite copyright or throw people in jail for breaking DRM when you have to justify infringing on their speech.

What's even better is that it stops us from all being scofflaws. When normal life breaks the law, the law has to change—a principle we seem to have forgotten.

I don't know if this kind of rewrite can happen politically, but it's the first copyright that's looked sane in a while.

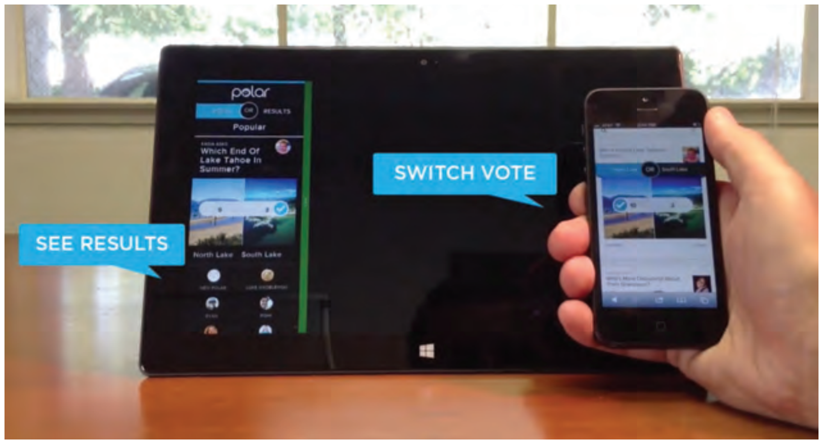
Quinn Norton writes about copyright for Wired News and other publications.

Microsoft Promotes 'Companion Web'

According to several surveys conducted in the past year by Nielsen and others, the overwhelming majority of smartphone users are on their mobile devices while watching television. As Microsoft increases its penetration into the mobile space, it's looking to take advantage of this phenomenon, using a system called the "companion web." Unfortunately, the demonstration provided on Microsoft's Windows blog appears to consist only of voting on answers to quiz questions on one device while you watch a related video on another. But there's a lot of potential for "push" content: Instead of looking up an actor on IMDb, or a historical event on Wikipedia, the trivia you're after would appear on your phone (or tablet or laptop) in real time, kind of like VH1's Pop Up Video.

The obvious advantage is increased engagement with the viewer, at a time when TV watching and cable subscriptions appear to be on a gradual but steady decline, in the face of the web's plethora of distractions and open forums. If you can bridge the gap created by commercial breaks, when most viewers flip to other programming (or do something else entirely), you can increase the chance of keeping them in front of the TV for the duration of the show, and sustain mindshare.

Not mentioned by Microsoft is the extent of personal data acquisition required for the companion web to know what info to deliver to you. There are also questions about where the funding would come from to provide the additional services and integration with existing websites and TV shows. **–TM**



Intel Profits Down 30 Percent

Intel announced its second-quarter financial results in late July: $12.8 billion in revenue, operating income of $2.7 billion, and net income of $2.0 billion, the latter of which is down 29 percent compared to a year ago. New CEO Brian Krzanich indicated that Intel was caught off-guard by the somewhat sudden decline in the traditional PC market as buyers apparently shifted to mobile. Intel's PC Client Group recorded $8.1 billion in revenue, up 1.4 percent sequentially and down 7.5 percent year-over-year. It's Data Center Group raked in $2.7 billion, a jump of 6.1 percent versus last quarter and flat year-over-year. **–PL**

LibreOffice Gets GPU Acceleration

If you've dealt with large Excel spreadsheets, you know they can take a long time to crunch numbers. AMD has joined up with the makers of LibreOffice (a fork of OpenOffice and competitor to Microsoft Office) to provide hardware acceleration via its GPUs. Specifically, certain calculations will be converted to the OpenCL programming language to be run on the video card's processor, instead of the computer's CPU. But AMD says some new lines of code should benefit users who do not even use discrete graphics. AMD also joined the advisory board of the Document Foundation, the publisher of OpenOffice. **–TM**

THE LIST

8 COOLEST THINGS AT SAN DIEGO COMIC-CON 2013



8 HYUNDAI VELOSTER TURBO CHOP SHOP CAR

Design your own undead-killing vehicle for the zombie apocalypse: http://bit.ly/112CrYW.



7 THE AWESOME BOOTHS

Check out this amazing statue of Azog at the WETA booth.



6 THE BOOTH MONSTERS

Booth babes are *so* 2012—booth monsters are where it's at!



5 THE WALKING DEAD ESCAPE

This zombie run is both exhilarating and scary! Watch online editor Jimmy Thang run through it here: http://bit.ly/12Wtv8A.



4 GETTING ZOMBIFIED

Future's Comic-Con booth was zombifying people for free on the show floor. Here is zombified Jimmy Thang.



3 THE COMIC-CON PARTIES

Future's Walking Dead/Hyundai–sponsored celebrity-filled party was definitely the best!



2 THE TOYS

Come for the parties, leave for the toys!



1 THE AMAZING COSPLAYS

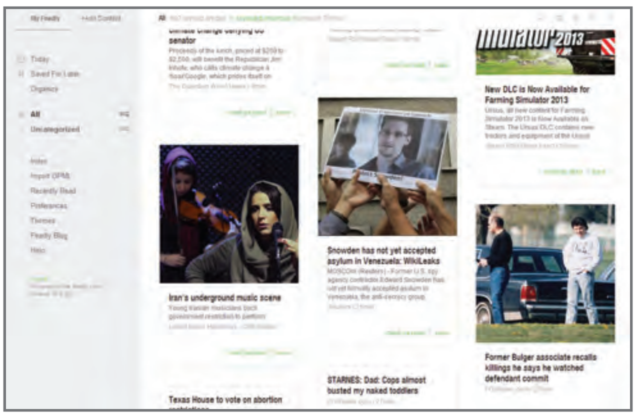
The number one reason to go to Comic-Con is to see all the amazing outfits!

HEAD TO HEAD

BY MARK PILKINGTON

Feedly vs. Digg Reader

When Google decided to pull the plug on its popular news reader, millions of users were left in a state of shock. The service they relied on to deliver their headlines and content since its 2005 launch came to an end on July 1, leaving a gaping hole in the market. However, with plenty of alternative RSS readers out there, it's fair to say users won't be stuck when it comes to choice. Feedly and Digg Reader are the two services that are in prime position to wear the vacated crown, but which one is the best choice? There's only one way to find out....



Already established and with a wide user base, Feedly is in prime position to benefit most from Google Reader's demise.

Round 1: Speed

When it comes to RSS readers, speed is an all-important commodity. Thankfully, in this case, both Feedly and Digg Reader are adept at delivering the latest headlines posthaste. It was a very close race, but Digg just nudges ahead for its slightly faster delivery and navigation. Because Feedly tends to be more graphically heavy and features animations, there's a more noticeable lag at times while it updates itself, especially when loading images as it refreshes its memory. This is partly rectified by selecting the "headline-only" option, of course, but even so it still lags ever-so-slightly behind Digg in the speed stakes.

Winner: Digg Reader

Round 2: Interface

When it comes to looks, Digg Reader is very much an advocate of minimalism. On the plus side, the layout is easy to navigate, albeit because it is so simple. Its uncluttered appearance is possibly a little too basic for most people's tastes, supporting just two viewpoints—the ability to list headlines only, or an expanded view showing images and the first few lines of text.

Feedly sports a much more bright and colorful interface that's similar in style to a magazine. You can select from a number of different views: titles only, images and text, a card layout (which separates each feed into boxes, à la Pinterest), and the full article in all its glory. The only criticism here is that things can look a little too busy if you are subscribed to hundreds of feeds at a time.

Winner: Tie

HEAD



The challenger with the most potential, can Digg Reader follow in Google's footsteps?

Round 3: Features

Feedly sports a raft of features. You can find feeds with a quick keyword search, selecting from different categories, or you can add each RSS feed via its URL. Chrome users benefit from an extension allowing them to add feeds from RSS websites at the click of a button. A full range of keyboard shortcuts are supported.

As it is such a new product, Digg Reader has notably fewer features. While you can add feeds in a similar way to Feedly, we struggled to find the same results and the categories were very limited. More worryingly, some feeds didn't even work at all.

Digg Reader's "popular" tag, showing the articles that are being read by other users, is a great way to find out what headlines are trending at any time of the day, while keyboard shortcuts are provided for easier navigation.

Winner: Feedly

Round 4: Platforms

Along with offering a web-based application that works on all major browsers, Feedly also caters to mobile users with its iOS and Android apps. Chrome and Firefox users can install an extension that integrates the site with the browser, allowing newsfeeds to be accessed via an icon. Digg Reader supports the same formats as Feedly, although its mobile Android app was delayed for a month after the main web-based and iOS services were launched. A Chrome browser extension has also been released. Feedly's mobile and tablet apps are more aesthetically pleasing, with colored folders separating feed categories, which are easy to navigate with the flick of a finger. As with its browser-based service, Digg Reader apps are a more somber affair, with plenty of white space helping to keep things simple, if not being rather dull to look at.

Winner: Feedly

Round 5: Sharing

Feedly is well positioned for sharing on social media, allowing you to post articles you like on Twitter, Facebook, LinkedIn, Buffer, and Google+. The works. You can also save articles to apps such as Pocket, Readability, and Instapaper, or send them to a contact via email.

While Digg Reader is not quite as share-friendly, you can still save articles to Instapaper and Pocket or Readability, and post on Facebook and Twitter. Digg Reader also has its unique "Digg" feature, as does its main site, which can be shared for the entire world to see. More share options, such as LinkedIn and Google+, are set to be launched over the coming months.

Winner: Feedly

And the Winner Is...

Feedly is the heir apparent to the RSS throne. Although we can appreciate that Digg Reader has only recently emerged from its beta phase, we were disappointed at the number of issues we found during testing, particularly with searching and adding feeds. Feedly, on the other hand, is far more established and much better for it. Easy to use yet packed full of functionality, Feedly is the promised land Google Reader refugees have been searching for.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Hot SLI Setups
> Old Games
> 2.2TB Partition Limits

2 Cards 2 Hot

I've got a solid gaming setup right now with a Core i5-750 at 3.2GHz on an Asus Maximus III Formula and 16GB of PNY Optima RAM. My problem is my two EVGA Superclocked GTX 550 Ti cards in SLI. Housed in a HAF922 chassis, I'm idling at 60 C and 40 C, and hitting 95 C and 80 C, respectively, under load, which is dangerously close to the 100 C maximum safe operating temperature. Ambient room temp isn't an issue, and the Core-i5 stays under 40 degrees. What would be the best option? I can go to a single GPU, though the 550s are super effective in gaming. I could get aftermarket cooling for the 550s. Or should I just get an even bigger tower?

—Vivaldi

THE DOCTOR RESPONDS: Have you tried adding an intake fan to the case's side panel? The HAF 922 can support another 20cm fan on the side. It's not the most elegant airflow solution, but blowing cold air directly onto the GPUs will help bring temperatures down.

The Doc believes that aftermarket cooling for your 550 Tis is probably not worth the expense. Put that money toward your next single-card setup, when the 550s can't keep up with your needs anymore.

Upgrade Path

I'm a retired soldier. I need an upgrade path for my current build. I am running an Asus P8P67 Pro Rev 3.1 with an Intel Core i5-2500K chip. I have two Nvidia GeForce GTX 560 Ti graphics cards. I still don't trust SSDs, so I have a normal hard drive. Besides a hard drive upgrade, what would you recommend as my next upgrade? And yes, money is an issue.

—Peter Walkoviak

THE DOCTOR RESPONDS: Sorry to hear you don't trust SSDs, because that's exactly what the Doc would recommend to upgrade your rig. The 2500K is still a fine CPU, and two 560 Tis in SLI should make quick work of most games. An SSD would dramatically improve your boot and load times and generally make your PC feel much speedier.

Other than a storage upgrade, it's hard to make additional recommendations without knowing what you use your computer for—and, say, how much RAM you have. You could get a newer CPU, like an i7-3770K, or you could upgrade to a faster, cooler, single GPU, but both would be more expensive than a good 250GB SSD such as the Samsung 840.

Rapid Start? More Like Doesn't Start

I have a 3-month-old Dell XPS 13 (model L321X) Ultrabook with a Core i5-2467M processor and a 128GB SSD running Windows 7 Home Premium. The Intel Rapid Start technology has not worked properly from day one. I've updated all the drivers and the BIOS but that didn't help. It works properly about 15 percent of the time, but the rest of the time this happens: The OS puts the computer into the S3 state, Rapid Start wakes it back up as designed, and then it hangs with a blank screen. It never transitions to the S4 state. The only way out at this point is to force a shutdown by holding the power button. Then on the next boot, it of course says Windows did not shut down correctly.

This is so annoying that I'm considering disabling Rapid Start entirely and going back to the standard Windows hibernate functionality. Would that have any negative long-term effects on my SSD?

—Geoff

THE DOCTOR RESPONDS: Dell acknowledges that the XPS 13 has had a problem with Intel's Rapid Start Technology, which basically slims down the image that needs to be written to "disk" and then hibernates it to a special 8GB partition on the SSD—think of it as fast hibernate. The problem is related to having the Trusted Platform Module enabled, which causes the system to hang. Dell apparently corrected the issue in a new BIOS, and with the latest drivers it should work. *Should work* and *works* are two different things, though, so you may want to try disabling the TPM if you're not using BitLocker on the machine to see if it helps your situation. For Rapid Start Technology to work, the system can't be in legacy IDE mode, and must have 8GB or less. It also doesn't work with Dell encryption accelerator cards, and certain devices might have conflicts if a BIOS password is set. You may also want to disable iRST, uninstall it, and reinstall it again, and then re-enable iRST.

Remove Files, Keep OS

I am giving my old laptop to a friend and I would like to delete everything but Windows 7 Ultimate. I have done some Googling on this, and the best result was to use Add and Remove Programs. But that does not get rid of documents, pictures, etc. I don't want to reinstall Windows because it's a real pain to do so. What do you suggest?

—Daniel Tassone

↘ submit your questions to: doctor@maximumpc.com

THE DOCTOR RESPONDS: Assuming your photos and documents are all in your user folder (My Documents, My Photos, My Videos, etc.) you can delete them by removing your user account. If your user account is the only one on the computer, you'll need to create a new one first. Then go to Control Panel > User Accounts and Family Safety > Manage Another Account. Select the account whose data you'd like to delete, then click Delete the Account. You'll be given an option to keep or delete the files associated with it; make sure to delete them.

After this, you should do a once-over of the rest of your hard drive, including your downloads folder and shared folders, to make sure there aren't still personal files in them. Be sure to empty the Recycle Bin before you hand the computer over. If you're really paranoid, you might want to run Erase (free from http://eraser.heidi.ie) to pave over the empty space to prevent someone from unerasing data.

You've Got To Keep Them Up-to-Dated

I'm a stickler for keeping my PC's software updated and currently use Secunia PSI, SlimWare Utilities' SlimCleaner, and FileHippo Update Checker. Each one misses updates, so I need to use all three to complement one another, which can be a pain. Do you know of any single updater (freeware or commercial) that will do the job alone?

—KT Renaud

THE DOCTOR RESPONDS: Unfortunately, we don't know of a single updater that will do a better job than those three combined. In fact, the more security-minded *Maximum PC* editors recommend running Qualys BrowserCheck (free, http://bit.ly/Sd8Vxn) as well, to plug holes in your browsers that the other updaters might not notice.

3TB Partition on Windows XP?

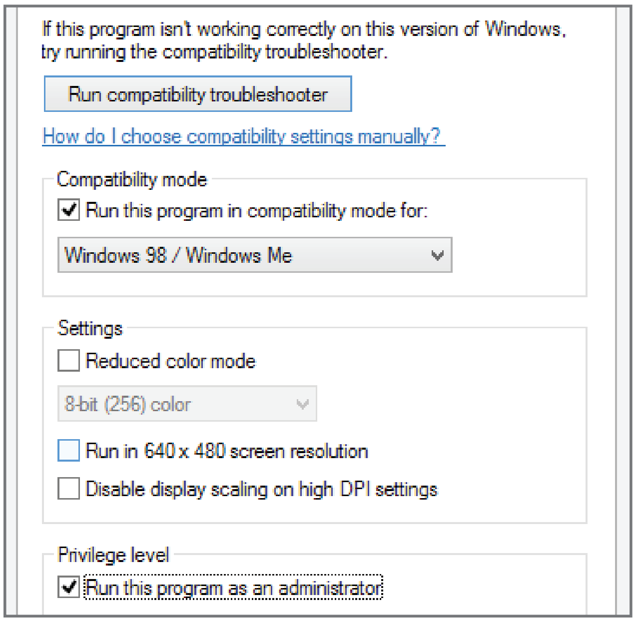
I have a 3TB Seagate hard disk drive. I have downloaded the Seagate Disk Wizard, which can locate the 3TB hard drive in the system.

Unfortunately, it splits the HDD into two partitions, one 2.1TB and one around 0.8TB. Both partitions I have NTFS formatted, no problem. However, I would like to have a single partition of around 2.8TB. Is this possible, and if so, how can it be done? The individual partition can be formatted using the Disk Manager on my XP operating system. I have tried Partition Magic but this does not allow me to expand the larger partition up to its maximum capacity.

—Trevor R. Wilkin

THE DOCTOR RESPONDS: In order to create a bootable partition over 2.2TB, you need a 64-bit OS that supports GPT partitions, as well as a motherboard with a UEFI rather than an old-fashioned BIOS. Unfortunately, Windows XP—even 64-bit Windows XP—can't support a partition bigger than 2.2TB. You'll need a 64-bit version of Vista or later.

Why do you need a 64-bit OS and a motherboard that supports UEFI? Because without those two things you're limited to 32-bit MBR-formatted disks. The MBR, or master boot record, tells the OS where everything is on the disk, and it uses 32-bit integers to do so. Two to the 32nd power is 4,294,967,296. Multiply that by the 512-byte sectors the disk is divided into, and you get 2.19TB—the maximum size of an MBR-formatted partition. A 64-bit system with a UEFI-capable motherboard can format a disk to use a GPT (or GUID Partition Table) that doesn't have that limitation. The good news is that you can still use that drive in XP; you just can't make a 3TB partition. If symmetry is your thing, you could use that Partition Magic software to make two 1.5TB drives.



Windows has built-in compatibility settings that can help fix problems with programs designed for older versions of the OS.

Resuscitating Old Games

I dug out some old games I'd love to play again: RollerCoaster Tycoon and its Loopy Landscapes expansion, Railroad Tycoon 2, and Re-Volt. Since I don't have a Win98 box any more, I bought VMWare Fusion 5 for my (I know) MacBook Air.

After loading the games in the Win98 VM machine they still won't launch. Something about sound drivers. I dug out an old Alienware rig circa 2003 with a 3.06GHz P4 processor, 2GB RAM, and GeForce 5600 FX GPU, loaded up 32-bit Win7 and installed the games. Only Railroad Tycoon works. I understand making a Win98 partition on the same HDD as Win7 is a nightmare. I also have a GeForce 6200 GPU I can try.

—Gee Gi

THE DOCTOR RESPONDS: There are a few ways you can fix this. First, you can try installing a sound driver in your virtual Windows 98 machine on your MacBook. Looking around at forums, VMWare's Win98 virtual machine seems to use a virtual SoundBlaster PCI 128 card, so you need to download the driver for it from Creative's website, which at press time you can find at (http://bit.ly/c1eTj5).

If that doesn't work, you can try to get the games running on your old Alienware. The Doc would recommend swapping in the GeForce 6200 you mentioned, only because there still seem to be Win7 drivers for it on Nvidia's website, where none are available for the 5600. Once you've swapped in the new card and updated the drivers, if the games still don't launch, it's time to check compatibility.

Right-click the .exe file for each game and select Properties. In the Compatibility tab, select "Run this program in compatibility mode for" and select Windows 98 / Windows ME. Go down to Privilege Level and select "Run this program as an administrator." Click OK and try to run the game again.

If absolutely all else fails, you can find a Windows 7–compatible version of RollerCoaster Tycoon Deluxe, which includes Loopy Landscapes, on Good Old Games for $6 (www.gog.com). Re-Volt is available in the iOS and Android app stores, and RollerCoaster Tycoon should be available on both this year.

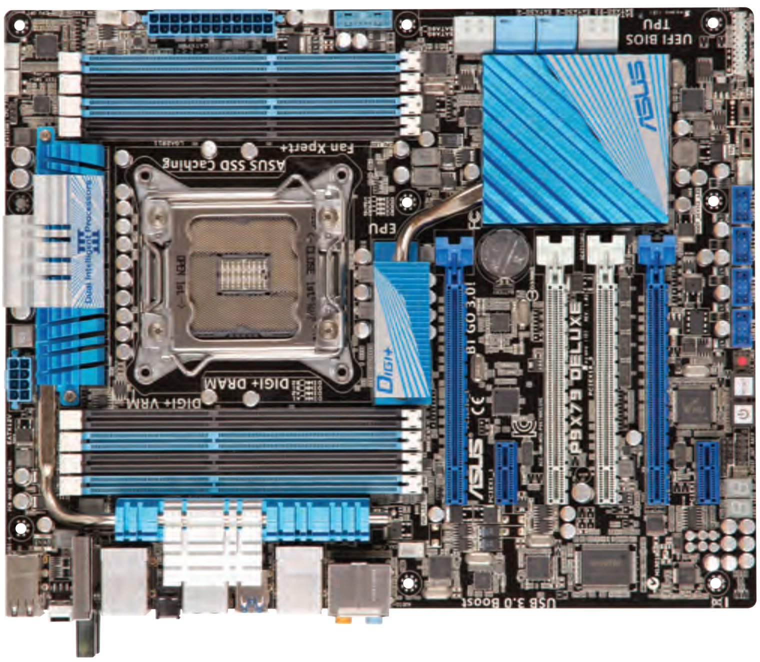
BY THE MAXIMUM PC STAFF

PUT IT TO THE TEST!

WITH OUR LAB COATS DONNED, OUR TEST BENCHES PRIMED, AND OUR BENCHMARKS AT THE READY, WE LOOK FOR ANSWERS TO NINE OF THE MOST BURNING PERFORMANCE-RELATED QUESTIONS



If there's one thing that defines the *Maximum PC* ethos, it's an obsession with Lab-testing. What better way to discern a product's performance capabilities, or judge the value of an upgrade, or simply settle a heated office debate? This month, we focus our obsession on several of the major questions on the minds of enthusiasts. Is liquid cooling always more effective than air? Should serious gamers demand PCIe 3.0? When it comes to RAM, are higher clocks better? On the surface, the answers might seem obvious. But, as far as we're concerned, nothing is for certain until it's put to the test. We're talking tests that isolate a subsystem and measure results using real-world workloads. Indeed, we not only want to know *if* a particular technology or piece of hardware is truly superior, but also by *how much*. After all, we're spending our hard-earned skrilla on this gear, so we want our purchases to make *real-world* sense. Over the next several pages, we put some of the most pressing PC-related questions to the test. If you're ready for the answers, read on.




GTX 780
NVIDIA
intel
Ivy Bridge
NZXT
COOLER MASTER
XPG
ADATA
XPG
ADATA

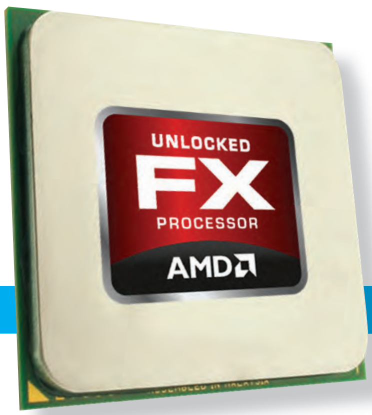
Core i5-4670K vs. Core i5-3570K vs. FX-8350

PEOPLE LIKE TO read about the $1,000 high-end parts, but the vast majority of enthusiasts don't buy at that price range. In fact, they don't even buy the $320 chips. No, the sweet spot for many budget enthusiasts is around $220. To find out which chip is the fastest midrange part, we ran Intel's new Haswell Core i5-4670K against the current-champ Core i5-3570K as well as AMD's Vishera FX-8350.

THE TEST: For our test, we socketed the Core i5-4670K into an Asus Z87 Deluxe with 16GB of DDR3/1600, an OCZ Vertex 3, a GeForce GTX 580 card, and Windows 8. For the Core i5-3570K, we used the same hardware in an Asus P8Z77-V Premium board, and the FX-8350 was tested in an Asus CrossHair V Formula board. We ran the same set of benchmarks that we used in our original review of the FX-8350 published in the Holiday 2012 issue.

THE RESULTS: First, the most important factor in the budget category is the price. As we wrote this, the street price of the Core i5-4670K was $240, the older Core i5-3570K was in the $220 range, and AMD's FX-8350 went for $200. The 4670K is definitely on the outer edge of the budget sweet spot while the AMD is cheaper by a bit.

One thing that's not disputable is the performance edge the new Haswell i5 part has. It stepped away from its Ivy Bridge sibling in every test we ran by respectable double-digit margins. And while the FX-8350 actually pulled close enough to the Core i5-3570K in enough tests to go home with some mul-



AMD's FX-8350 has two cores up on the competition, but does that matter?



Intel's Haswell Core i5-4670K slots right into the high end of the midrange.



The Core i5-3570K was great in its day, but it needs more than that to stay on top.

BENCHMARKING: SYNTHETIC VS. REAL-WORLD

There's a tendency for testers to dismiss "synthetic" benchmarks as having no value whatsoever, but that attitude is misplaced. Synthetics got their bad name in the 1990s, when they were the only game in town for testing hardware. Hardware makers soon started to optimize for them, and on occasion, those actions would actually hurt performance in real games and applications.

The 1990s are long behind us, though, and benchmarks and the benchmarking community have matured to the point that synthetics can offer very useful metrics when measuring the performance of a single component or system. At the same time, real-world benchmarks aren't untouchable. If a developer receives funding or engineering support from a hardware maker to optimize a game or app, does that really make it neutral? There is the argument that it doesn't matter because if there's "cheating" to improve performance, that only benefits the users. Except that it only benefits those using a certain piece of hardware.

In the end, it's probably more important to understand the nuances of each benchmark and how to apply them when testing hardware. SiSoft Sandra, for example, is a popular synthetic benchmark with a slew of tests for various components. We use it for memory bandwidth testing, for which it is invaluable—as long as the results are put in the right context. A doubling of main system memory bandwidth, for example, doesn't mean you get a doubling of performance in games and apps. Of course, the same caveats apply to real-world benchmarks, too.

tithreaded victories in its pocket, it was definitely kept humble by Haswell. The Core i5-4670K plain-and-simply trashed the FX-8350 in the vast majority of the tests that can't push all eight cores of the FX-8350. Even worse, in the multithreaded tests where the FX-8350 squeezed past the Ivy Bridge Core i5-3570K, Haswell either handily beat or tied the chip with twice its cores.

Even folks concerned with bang-for-the-buck will find the Core i5-4670K makes a compelling argument. Yes, it's 20 percent more expensive than the FX-8350, but in some of our benchmarks, it was easily that much faster or more. In Stitch.Efx 2.0, for example, the Haswell was 80 percent faster than the Vishera. Ouch.

So where does this leave us? For first place, we're proclaiming the Core i5-4570K the midrange king by a margin wider than Louie Anderson. Even the most ardent fanboys wearing green-tinted glasses or sporting an IVB4VR license plate can't disagree.

For second place, however, we're going to get all controversial and call it for the FX-8350, by a narrow margin. Here's why: FX-8350 actually holds up against the Core i5-3570K in a lot of benchmarks, has an edge in mulitithreaded apps, and its AM3+ socket has a far longer roadmap than LGA1155, which is on the fast track to Palookaville.

Granted, Ivy Bridge and 1155 is still a great option, especially when bought on a discounted combo deal, but it's a dead man walking, and our general guidance for those who like to upgrade is to stick to sockets that still have a pulse. Let's not even mention that LGA1155 is the only one here with a pathetic two SATA 6Gb/s ports. Don't agree? Great, because we have an LGA1156 motherboard and CPU to sell you.

BENCHMARKS

	Core i5-4670K	Core i5-3570K	FX-8350
POV Ray 3.7 RC3 (sec)	**168.53**	227.75	184.8
Cinebench 10 Single-Core	**8,500**	6,866	4,483
Cinebench 11.5	**6.95**	6.41	**6.90**
7Zip 9.20	17,898	17,504	**23,728**
Fritz Chess	**13,305**	11,468	12,506
Premiere Pro CS6 (sec)	**2,849**	3,422	5,220
HandBrake Blu-ray encode (sec)	**9,042**	9,539	8,400
x264 5.01 Pass 1 (fps)	**66.3**	57.1	61.3
x264 5.01 Pass 2 (fps)	**15.8**	12.7	**15**
Sandra (GB/s)	**21.6**	**21.3**	18.9
Stitch.Efx 2.0 (sec)	**836**	971	1,511
ProShow Producer 5 (sec)	**1,275**	1,463	1,695
STALKER: CoP low-res (fps)	**173.5**	167.3	132.1
3DMark 11 Physics	**7,938**	7,263	7,005
PC Mark 7 Overall	**6,428**	5,582	4,408
PC Mark 7 Storage	5,300	**5,377**	4,559
Valve Particle (fps)	**180**	155	119
Heaven 3.0 low-res (fps)	**139.4**	138.3	134.4

Best scores are bolded. Test bed described in text.

Hyper-Threading vs. No Hyper-Threading

HYPER-THREADING came out 13 years ago with the original 3.06GHz Pentium 4, and was mostly a dud. Few apps were multithreaded and even Windows's own scheduler didn't know how to deal with HT, making some apps actually slow down when the feature was enabled. But the tech overcame those early hurdles to grow into a worthwhile feature today. Still, builders are continually faced with choosing between procs with and without HT, so we wanted to know definitively how much it matters.

THE TEST: Since we haven't actually run numbers on HT in some time, we broke out a Core i7-4770K and ran tests with HT turned on and off. We used a variety of benchmarks with differing degrees of threadedness to test the technology's strengths and weaknesses.

THE RESULTS: One look at our results and you can tell HT is well worth it if your applications can use the available threads. We saw benefits of 10–30 percent from HT in some apps. But if your app can't use the threads, you gain nothing. And in rare instances, it appears to hurt performance slightly—as in Hitman: Absolution when run to stress the CPU rather than the GPU. Our verdict is that you should pay for HT, but only if your chores include 3D modeling, video encoding or transcoding, or other thread-heavy tasks. Gamers who occasionally transcode videos, for example, would get more bang for their buck from a Core i5-4670K.

BENCHMARKS

	HT Off	HT On
PCMark 7 Overall	6,308	**6,348**
Cinebench 11.5	6.95	**8.88**
Stitch.EFx 2.0 (sec)	772	772
ProShow Producer 5.0 (sec)	1,317	**1,314**
Premiere Pro CS6 (sec)	2,950	**2,522**
HandBrake 0.9.9 (sec)	1,200	**1,068**
3DMark 11 Overall	X2,210	X2,209
Valve Particle Test (fps)	191	**226**
Hitman: Absolution, low res (fps)	**92**	84
Total War 2: Shogun CPU Test (fps)	**42.4**	41

Best scores are bolded. We used a Core i7-4770K on a Asus Z87 Deluxe, with a Neutron GTX 240 SSD, a GeForce GTX 580, and 16GB of DDR3/1600 64-bit, with Windows 8.

Air Cooling vs. Water Cooling

THERE ARE TWO main ways to chill your CPU: a heatsink with a fan on it, or a closed-loop liquid cooler (CLC). Unlike a custom loop, you don't need to periodically drain and flush the system or check it for leaks. The "closed" part means that it's sealed and integrated. This integration also reduces manufacturing costs and makes the setup much easier to install. If you want maximum overclocks, custom loops are the best way to go. But it's a steep climb in cost for a modest improvement beyond what current closed loops can deliver.

But air coolers are not down for the count. They're still the easiest to install and the cheapest. However, the prices between air and water are so close now that it's worth taking a look at the field to determine what's best for your budget.

THE TEST: To test the two cooling methods, we dropped them into a rig with a hex-core Intel Core i7-3960X overclocked to 4.25GHz on an Asus Rampage IV Extreme motherboard, inside a Corsair 900D. By design, it's kind of a beast and tough to keep cool.

THE BUDGET CLASS

THE RESULTS: At this level, the Cooler Master 212 Evo is legend…ary. It runs cool and quiet, it's easy to pop in, it can adapt to a variety of sockets, it's durable, and it costs about 30 bucks. Despite the 3960X's heavy load, the 212 Evo averages about 70 degrees C across all six cores, with a room temperature of about 22 C, or 71.6 F. Things don't tend to get iffy until 80 C, so there's room to go even higher. Not bad for a cooler with one 120mm fan on it.

Entry-level water coolers cost substantially more, unless you're patient enough to wait for a fire sale. They require more materials, more manufacturing, and more complex engineering. The Cooler Master Seidon 120M is a good example of the kind of unit you'll find at this tier. It uses a standard 120mm fan attached to a standard 120mm radiator (or "rad") and currently has a street price of $60. But in our tests, its thermal performance was about the same, or worse, than the 212 Evo. In order to meet an aggressive price target, you have to make some compromises. The pump is smaller than average, for example, and the copper block you install on top of the CPU is not as thick. The Seidon was moderately quieter, but we have to give the nod to the 212 Evo when it comes to raw performance.



The Cooler Master 212 Evo has arguably the best price-performance ratio around.

IS HIGH-BANDWIDTH RAM WORTH IT?

Today, you can get everything from vanilla DDR3/1333 all the way to exotic-as-hell DDR3/3000. The question is: Is it actually worth paying for anything more than the garden-variety RAM?

THE TEST: For our test, we mounted a Core i7-4770K into an Asus Z87 Deluxe board and fitted it with AData modules at DDR3/2400, DDR3/1600, and DDR3/1333. We then picked a variety of real-world (and one synthetic) tests to see how the three compared.

THE RESULTS: First, let us state that if you're running integrated graphics and you want better 3D performance, pay for higher-clocked RAM. With discrete graphics, though, the advantage isn't as clear. We had several apps that saw no benefit from going from 1,333MHz to 2,400MHz. In others, though, we saw a fairly healthy boost, 5–10 percent, by going from standard DDR3/1333 to DDR3/2400. The shocker



DDR3/2400 RAM does yield some performance, but perhaps not enough to justify the higher prices.



It may not look like much, but the Kraken X60 is the Ferrari of closed-loop coolers.

THE PERFORMANCE CLASS

THE RESULTS: While a CLC has trouble scaling its manufacturing costs down to the budget level, there's a lot more headroom when you hit the $100 mark. The NZXT Kraken X60 CLC is one of the best examples in this class; its dual–140mm fans and 280mm radiator can unload piles of heat without generating too much noise, and it has a larger pump and apparently larger tubes than the Seidon 120M. Our tests bear out the promise of the X60's design, with its "quiet" setting delivering a relatively chilly 66 C, or about 45 degrees above the ambient room temp.

Is there any air cooler that can keep up? Well, we grabbed a Phanteks TC14PE, which uses two heatsinks instead of one, dual–140mm fans, and retails at $85–$90. It performed only a little cooler than the 212 Evo, but it did so very quietly, like a ninja. At its quiet setting, it trailed behind the X60 by 5 C. It may not sound like much, but that extra 5 C of headroom means a higher potential overclock. So, water wins the high end.

BENCHMARKS

	Seidon 120M Quiet / Performance Mode	212 Evo Quiet / Performance Mode	Kraken X60 Quiet / Performance Mode	TC14PE Quiet / Performance Mode
Ambient Air	22.1 / 22.2	20.5 / 20	20.9 / 20.7	20 / 19.9
Idle Temperature	38 / 30.7	35.5 / 30.5	**29.7 / 28.8**	32 / **28.5**
Load Temperature	78.3 / 70.8	70 / 67.3	**66 / 61.8**	70.3 / 68.6
Load - Ambient	56.2 / 48.6	49.5 / 47.3	**45.1 / 41.1**	50.3/ 48.7

All temperatures in degrees Celsius. Best scores bolded.

came in Dirt 3, which we ran in low-quality modes so as not to be bottlenecked by the GPU. At low resolution and low image quality, we saw an astounding 18 percent boost.

To keep you back on earth, you should know that cranking the resolution in the game all but erased the difference. To see any actual benefit, we think you'd really need a tri-SLI GeForce GTX 780 setup and expect that the vast majority of games won't actually give you that scaling.

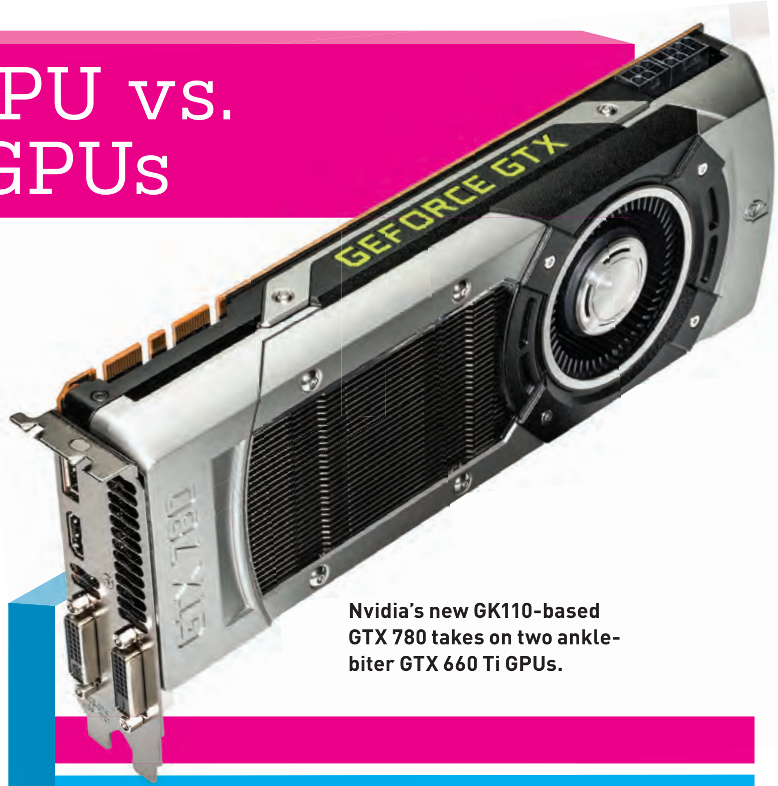
We think the sweet spot for price/performance is either DDR3/1600 or DDR3/1866.

BENCHMARKS

	DDR3/1333	DDR3/1600	DDR3/2400
Stitch.Efx 2.0 (sec)	776	773	**763**
PhotoMatix HDR (sec)	181	180	180
ProShow Producer 5.0 (sec)	1,370	1,337	**1,302**
HandBrake 0.9.9 (sec)	1,142	1,077	**1,037**
3DMark Overall	2,211	2,214	2,215
Dirt 3 Low Quality (fps)	234	247.6	**272.7**
Price for two 4GB DIMMs (USD)	$70	$73	$99

All temperatures in degrees Celsius. Best scores bolded.

One High-End GPU vs. Two Midrange GPUs



Nvidia's new GK110-based GTX 780 takes on two ankle-biter GTX 660 Ti GPUs.

ONE OF THE MOST COMMON questions we get here at *Maximum PC*, aside from details about our lifting regimen, is whether to upgrade to a high-end GPU or run two less-expensive cards in SLI or CrossFire. It's a good question, since high-end GPUs are expensive, and cards that are two rungs below them in the product stack cost about half the price, which naturally begs the question: Are two $300 cards faster than a single $600 card? Before we jump to the tests, dual-card setups suffer from a unique set of issues that need to be considered. First is the frame-pacing situation, where the cards are unable to deliver frames evenly, so even though the overall frames per second is high there is still micro-stutter on the screen. Nvidia and AMD dual-GPU configs suffer from this, but Nvidia's SLI has less of a problem than AMD at this time. Both companies also need to offer drivers to allow games and benchmarks to see both GPUs, but they are equally good at delivering drivers the day games are released, so the days of waiting two weeks for a driver are largely over.

2X NVIDIA GTX 660 TI VS. GTX 780

THE TEST: We considered using two $250 GTX 760 GPUs for this test, but Nvidia doesn't have a $500 GPU to test them against, and since this is *Maximum PC*, we rounded up one model from the "mainstream" to the $300 GTX 660 Ti. This video card was recently replaced by the GTX 760, causing its price to drop down to a bit below $300, but since that's its MSRP we are using it for this comparison. We got two of them to go up against the GTX 780, which costs $650, so it's not a totally fair fight, but we figured it's close enough for government work. We ran our standard graphics test suite in both single- and dual-card configurations.

THE RESULTS: It looks like our test was conclusive—two cards in SLI provide a slightly better gaming experience than a single badass card, taking top marks in seven out of nine tests. And they cost less, to boot. Nvidia's frame-pacing was virtually without issues, too, so we don't have any problem recommending Nvidia SLI at this time. It is the superior cost/performance setup as our benchmarks show.

2X RADEON HD 7790 VS. RADEON HD 7970 GHZ

THE TEST: For our AMD comparison, we took two of the recently released HD 7790 cards, at $150 each, and threw them into the octagon with a $400 GPU, the PowerColor Radeon HD 7970 Vortex II, which isn't technically a "GHz" board, but is clocked at

PCI EXPRESS 2.0 VS. PCI EXPRESS 3.0

PCI Express is the specification that governs the amount of bandwidth available between the CPU and the PCI Express slots on your motherboard. We've recently made the jump from version 2.0 to version 3.0, and the PCI Express interface on all late-model video cards is now PCI Express 3.0, causing many frame-rate addicts to question the sanity of placing a PCIe 3.0 GPU into a PCIe 2.0 slot on their motherboard. The reason why is that PCIe 3.0 has quite a bit more theoretical bandwidth than PCIe 2.0. Specifically, one PCIe 2.0 lane can transmit 500MB/s in one direction, while a PCIe 3.0 lane can pump up to 985MB/s, so it's almost double the bandwidth, and then multiply that by 16, since there are that many lanes being used, and the difference is substantial. However, that extra bandwidth will only be important if it's even needed, which is what we wanted to find out.

THE TEST: We plugged an Nvidia GTX Titan into our Asus P9X79 board and ran several of our gaming tests with the top PCI Express x16 slot alternately



Our motherboard let us toggle between Gen 2.0 and Gen 3.0 easily, though X79 doesn't natively support Gen 3.0.



Two little knives of the HD 7790 ilk take on the big gun Radeon HD 7970 .

1,100MHz, so we think it qualifies. We ran our standard graphics test suite in both single-and-dual card configurations.

THE RESULTS: Our AMD tests resulted in a very close battle, with the dual-card setup taking the win by racking up higher scores in six out of nine tests, and the single HD 7970 card taking top spot in the other three tests. But, what you *can't* see in the chart is that the dual HD 7790 cards were totally silent while the HD 7970 card was loud as hell. Also, AMD has acknowledged the micro-stutter problem with CrossFire, and promises a software fix for it, but unfortunately that fix is going to arrive right as we are going to press on July 31. Even without it, gameplay seemed smooth, and the duo is clearly faster, so it gets our vote as the superior solution, at least in this config.

BENCHMARKS

	GTX 660 Ti SLI	GTX 780	Radeon HD 7870 CrossFire	Radeon HD 7970 GHz
3DMark Fire Strike	**8,858**	8,482	**8,842**	7,329
Catzilla (Tiger) Beta	**7,682**	6,933	**6,184**	4,889
Unigine Heaven 4.0 (fps)	33	**35**	**30**	24
Crysis 3 (fps)	**26**	24	15	**17**
Shogun 2 (fps)	**60**	48	**51**	43
Far Cry 3 (fps)	**41**	35	21	**33**
Metro: Last Light (fps)	**24**	22	13	**14**
Tomb Raider (fps)	18	**25**	**24**	20
Battlefield 3 (fps)	**56**	53	**57**	41

Best scores are bolded. Our test bed is a 3.33GHz Core i7 3960X Extreme Edition in an Asus P9X79 motherboard with 16GB of DDR3/1600 and a Thermaltake ToughPower 1,050W PSU. The OS is 64-bit Windows 7 Ultimate. All tests, except for the 3DMark tests, are run at 2560x1600 with 4X AA.

set to PCIe 3.0 and PCIe 2.0. On this particular board you can switch the setting in the BIOS.

THE RESULTS: We had heard previously that there was very little difference between PCIe 2.0 and PCIe 3.0 on current systems, and our tests back that up. In every single test, Gen 3.0 was faster, but the difference is so small it's very hard for us to believe that PCIe 2.0 is being saturated by our GPU. It's also quite possible that one would see more pronounced results using two or more cards, but we wanted to "keep it real" and just use one card.

BENCHMARKS

	GTX Titan PCIe 2.0	GTX Titan PCIe 3.0
3DMark Fire Strike	9,363	**9,892**
Unigine Heaven 4.0 (fps)	37	**40**
Crysis 3 (fps)	31	**32**
Shogun 2 (fps)	60	**63**
Far Cry 3 (fps)	38	**42**
Metro: Last Light (fps)	22	**25**
Tomb Raider (fps)	22	**25**

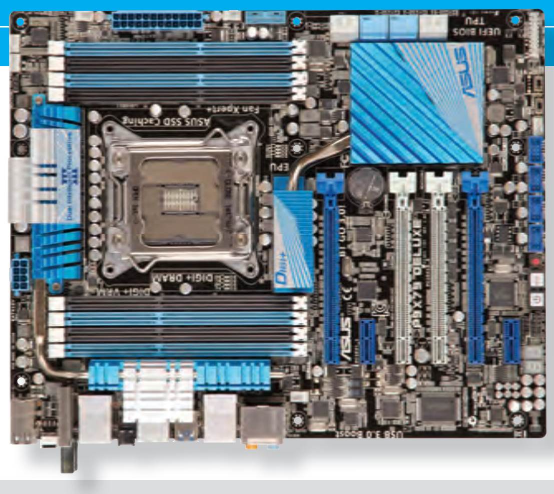
Best scores are bolded. Our test bed is a 3.33GHz Core i7 3960X Extreme Edition in an Asus P9X79 motherboard with 16GB of DDR3/1600 and a Thermaltake ToughPower 1,050W PSU. The OS is 64-bit Windows 7 Ultimate. All games are run at 2560x1600 with 4X AA except for the 3DMark tests.

PCIe x8 vs. PCIe x16

PCI EXPRESS expansion slots vary in both physical size and the amount of bandwidth they provide. The really long slots are called x16 slots, as they provide 16 lanes of PCIe bandwidth, and that's where our video cards go, for obvious reasons. Almost all of the top slots in a motherboard (those closest to the CPU) are x16, but sometimes those 16 lanes are divided between two slots, so what might look like a x16 slot is actually a x8 slot. The tricky part is that sometimes the slots below the top slot only offer eight lanes of PCIe bandwidth, and sometimes people need to skip that top slot because their CPU cooler is in the way or water cooling tubes are coming out of a radiator in that location. Or you might be running a dual-card setup, and if you use a x8 slot for one card, it will force the x16 slot to run at x8 speeds. Here's the question: Since a x16 slot provides 3.2GB/s of bandwidth in one direction, and a x8 slot pumps 1.6GB/s, is your performance hobbled by running at x8?

THE TEST: We wedged a GTX Titan into first a x16 slot and then a x8 slot on our Asus P9X79 motherboard and ran our gaming tests in order to compare the difference.

THE RESULTS: We were surprised by these results, which show x16 to be a clear winner. Sure, it seems obvious, but we didn't think even current GPUs were saturating the x8 interface, but apparently they are, so this is an easy win for x16.



The Asus P9X79 offers two x16 slots (blue) and two x8 slots (white).

BENCHMARKS

	GTX Titan PCIe x16	GTX Titan PCIe x8
3DMark Fire Strike	**9,471**	9,426
Catzilla (Tiger) Beta	**7,921**	7,095
Unigine Heaven 4.0 (fps)	**40**	36
Crysis 3 (fps)	32	**37**
Shogun 2 (fps)	**64**	56
Far Cry 3 (fps)	**43**	39
Metro: Last Light (fps)	**25**	22
Tomb Raider (fps)	**25**	23
Battlefield 3 (fps)	**57**	50

Tests performed on an Asus P9X79 Deluxe motherboard.

IDE vs. AHCI

IF YOU GO into your BIOS and look at the options for your motherboard's SATA controller, you usually have three options: IDE, AHCI, and RAID. RAID is for when you have more than one drive, so for running just a lone wolf storage device, you have AHCI and IDE. For ages we always just ran IDE, as it worked just fine. But now there's AHCI too, which stands for Advanced Host Controller Interface, and it supports features IDE doesn't, such as Native Command Queuing (NCQ), and hot swapping. Some people also claim that AHCI is faster than IDE due to NCQ and the fact that it's newer. Also, for SSD users, IDE does not support the Trim command, so AHCI is critical to an SSD's well-being over time, but is there a speed difference between IDE and AHCI for an SSD? We set to find out.

THE TEST: We enabled IDE on our SATA controller in the BIOS, then installed our OS. Next, we added our Corsair test SSD and ran a suite of storage tests. We then enabled AHCI, reinstalled the OS, re-added the Corsair Neutron test SSD, and re-ran all the tests.

THE RESULTS: We haven't used IDE in a while, but we assumed it would allow our SSD to run at full speed even if it couldn't NCQ or hot-swap anything. And we were wrong. Dead wrong. Performance with the SATA controller set to IDE was abysmal, plain and simple.

BENCHMARKS

	Corsair Neutron GTX IDE	Corsair Neutron GTX AHCI
CrystalDiskMark		
Avg. Sustained Read (MB/s)	224	**443**
Avg. Sustained Write (MB/s)	386	**479**
AS SSD - Compressed Data		
Avg. Sustained Read (MB/s)	210	**514**
Avg. Sustained Write (MB/s)	386	**479**
ATTO		
64KB File Read (MB/s, 4QD)	151	**351**
64KB File Write (MB/s, 4QD)	354	**485**
Iometer		
4KB Random Write 32QD (IOPS)	19,943	**64,688**
PCMark Vantage x64	6,252	**41,787**

Best scores are bolded. All tests conducted on our hard drive test bench, which consists of a Gigabyte Z77X-UP4 motherboard, Intel Core i5-3470 3.2GHz CPU, 8GB of RAM, Intel 520 Series SSD, and a Cooler Master 450W power supply.

SSD RAID vs. Single SSD

THIS TEST IS somewhat analogous to the GPU comparison, as most people would assume that two small-capacity SSDs in RAID 0 would be able to outperform a single 256GB SSD. The little SSDs have a performance penalty out of the gate, though, as SSD performance usually improves as capacity increases because the controller is able to grab more data given the higher-capacity NAND wafers—just like higher-density platters increase hard drive performance. This is not a universal truth, however, and whether or not performance scales with an SSD's capacity depends on the drive's firmware, NAND flash, and other factors, but in general, it's true that the higher the capacity of a drive, the better its performance. The question then is: Is the performance advantage of the single large drive enough to outpace two little drives in RAID 0?

Before we jump into the numbers, we have to say a few things about SSD RAID. The first is that with the advent of SSDs, RAID setups are not quite as common as they were in the HDD days, at least when it comes to what we're seeing from boutique system builders. The main reason is that it's really not that necessary since a stand-alone SSD is already extremely fast. Adding more speed to an already-fast equation isn't a big priority for a lot of home users (this is not necessarily our audience, mind you). Even more importantly, the biggest single issue with SSD RAID is that the operating system is unable to pass the Trim command to the RAID controller in most configurations (Intel 7 and 8 series chipsets excluded), so the OS can't tell the drive how to keep itself optimized, which can degrade performance of the array in the long run, making the entire operation pointless. Now, it's true that the drive's controller will perform "routine garbage collection," but how that differs from Trim is uncertain, and whether it's able to manage the drive equally well is also unknown. However, the lack of Trim support on RAID 0 is a scary thing for a lot of people, so it's one of the

> "THE BIGGEST ISSUE WITH SSD RAID IS THAT THE OS CAN'T PASS THE TRIM COMMAND



It's David and Goliath all over again, as two puny SSDs take on a bigger, badder drive.

INTEL AND AMD ON TRIMMING YOUR RAID

If you'd love to run SSD RAID but don't because you've heard that the controllers don't support the Trim command, you were right in early 2012, but times have changed, son. Today, Intel supports passing Trim through RAID, but in order to do so you need the following: Intel's Rapid Storage Technology (iRST) software version 11 or later, two SSDs already in RAID, and an Intel 7- or 8-series chipset mobo. If you have an Intel 6-series mobo or older, or an AMD system, you are SOL for now, and will have to use the SSD's built-in garbage collection instead. Theoretically, it should work just fine though, so don't be afraid.

reasons SSD RAID often gets avoided. Personally, we've never seen it cause any problems, so we are fine with it. We even ran it in our Dream Machine 2013, and it rocked the Labizzle. So, even though people will say SSD RAID is bad because there's no Trim support, we've never been able to verify exactly what that "bad" means long-term.

THE TEST: We plugged in two Corsair Neutron SSDs, set the SATA controller to RAID, created our array with a 64K stripe size, and then ran all of our tests off an Intel 520 SSD boot drive. We used the same protocol for the single drive.

THE RESULTS: The results of this test show a pretty clear advantage for the RAIDed SSDs, as they were faster in seven out of nine tests. That's not surprising, however, as RAID 0 has always been able to benchmark well. That said, the single 256 Corsair Neutron drive came damned close to the RAID in several tests, including CrystalDiskMark, ATTO at four queue depth, and AS SSD. It's not completely an open-and-shut case, though, because the RAID scored poorly in the PC Mark Vantage "real-world" benchmark, with just one-third of the score of the single drive. That's cause for concern, but with these scripted tests it can be tough to tell exactly where things went wrong, since they just run and then spit out a score. Also, the big advantage of RAID is that it boosts sequential-read and -write speeds since you have two drives working in parallel (conversely, you typically won't see a big boost for the small random writes made by the OS). Yet the SSDs in RAID were actually slower than the single SSD in our Sony Vegas "real-world" 20GB file encode test, which is where they should have had a sizable advantage. For now, we'll say this much: The RAID numbers look good, but more "real-world" investigation is required before we can tell you one is better than the other.

BENCHMARKS

	1x Corsair Neutron 256GB	2x Corsair Neutron 128GB RAID 0
CrystalDiskMark		
Avg. Sustained Read (MB/s)	512	**593**
Avg. Sustained Write (MB/s)	436	**487**
AS SSD - Compressed Data		
Avg. Sustained Read (MB/s)	506	**647**
Avg. Sustained Write (MB/s)	318	**368**
ATTO		
64KB File Read (MB/s, 4QD)	436	**934**
64KB File Write (MB/s, 4QD)	**516**	501
Iometer		
4KB Random Write 32QD (IOPS)	70,083	**88,341**
PCMark Vantage x64	**70,083**	23,431
Sony Vegas Pro 9 Write (sec)	343	**429**

Best scores are bolded. All tests conducted on our hard-drive test bench, which consists of a Gigabyte Z77X-UP4 motherboard, Intel Core i5-3470 3.2GHz CPU, 8GB of RAM, Intel 520 Series SSD, and a Cooler Master 450W power supply.

AVOID THE BENCHMARKING PITFALLS

Even seasoned veterans are tripped up by benchmarking pitfalls, so beginners should be especially wary of making mistakes. Here are a few tips to help you on your own testing journey.

Put away your jump-to-conclusions mat. If you set condition A and see a massive boost—or no difference at all when you were expecting one—don't immediately attribute it to the hardware. Quite often, it's the tester introducing errors into the test conditions that causes the result. Double-check your settings and re-run your tests and then look for feedback from others who have tested similar hardware to use as sanity-check numbers.

When trying to compare one platform with another (certainly not ideal)—say, a GPU in system A against a GPU in system B—be especially wary of the differences that can result simply from using two different PCs, and try to make them as similar as possible. From drivers to BIOS to CPU and heatsink—everything should match. You may even want to put the same GPU in both systems to make sure the results are consistent.

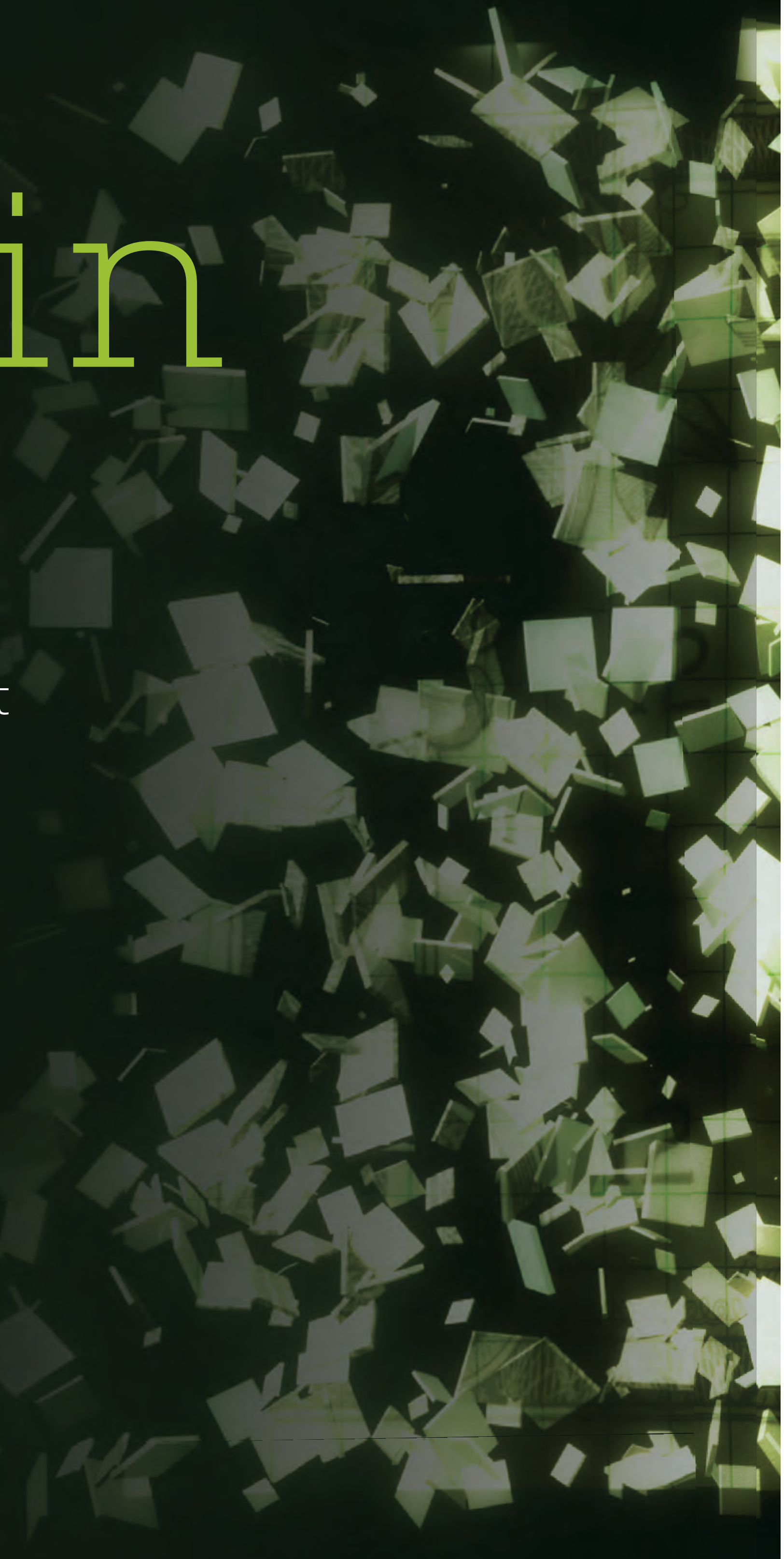
Use the right benchmark for the hardware. Running Cinebench 11.5—a CPU-centric test—to review memory, for example, would be odd. A better fit would be applications that are more memory-bandwidth sensitive, such as encoding, compression, synthetic RAM tests, or gaming.

Be honest. Sometimes, when you shell out for new hardware, you want it to be faster because no one wants to pay through the nose to see no difference. Make sure your own feelings toward the hardware aren't coloring the results.

Bitcoin 101

Everything you need to know to start cranking out cash with your PC

BY JULIAN REICHE



BITCOIN is a new kind of virtual currency that exists only in the mysterious world of the Internet. It sprang up after the financial crisis of 2008, when people fearing that the sky was falling began investing in gold bars and silver coins. Many geeks also feared the apocalypse was nigh, but they chose to invest not in old-world currencies, but in a new currency created from scratch and made up of digital bits. That currency is Bitcoin.

What's really interesting about this brand-new currency is that it's mined through good old-fashioned hard work—by your PC though, not you. You simply run a program on your computer and eventually a virtual coin will appear. The more powerful your setup, the faster the coins will arrive, theoretically at least. It's very similar to the SETI@home and Folding@home programs, in that it uses spare computing cycles to help churn through complicated equations, but this time the equations result in a payday for the person willing to devote the resources necessary to acquire them. Of course, it's not quite that simple, and there are pitfalls and caveats, as always, so follow along while we take you on a brief tour of this brave new frontier. And if you become a virtual millionaire down the road, we want a finder's fee.


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What Is Bitcoin?



TERMINOLOGY
Bitcoin = system
bitcoin = unit of currency

Bitcoins come in four denominations and even exist in rarely seen physical form, which essentially functions like a gift card, with an identifiable alphanumeric address/key that's entered online.

Bitcoin is a decentralized virtual currency that exists solely online. You generate bitcoins with your computer, stuff bitcoins into a virtual wallet, trade them with others, and eventually cash out if you want. Since there is no central authority or government agency providing oversight, users are allowed to semi-anonymously transfer money to one another, making it similar to any other peer-to-peer transaction, except this time, instead of swapping torrents, you're swapping virtual cash. This lack of oversight is one of the key benefits, and downsides, to Bitcoin at this time, making it the latest frontier in the battle over how much freedom should exist in the online world. This state of anarchy has also made Bitcoin quite intriguing for people who have a lot of spare GPU cycles, which is a wide swath of the *Maximum PC* readership. But before you fire up your GPUs and quit your day job, let's examine the basics of Bitcoin so you can decide if it's something you even want to bother with, because—spoiler alert—it's not for everybody.

Bitcoin Basics

Bitcoin currency consists of four denominations, with the largest being one bitcoin (BTC), followed by a milicoin with a value of 0.001 BTC. One step lower is a microcoin with a value of 0.000001 BTC, and the smallest denomination is a satoshi, with a value of 0.00000001 BTC. Since its inception in 2009, bitcoin value has varied widely: $1 could buy you one bitcoin at the beginning of 2011, but you'd need $230 to buy that same bitcoin in April 2013, making it a damned good investment for those who got in early. Bitcoin is a different kind of currency though, so naturally it works a bit differently than traditional currencies. While your local bank keeps a private ledger for deposits and withdrawals, Bitcoin's ledger, called the block chain, is public, and everyone can download a copy. This allows anyone to effectively audit transactions sent over the network, which has elicited fears of a Panopticon of constant surveillance. This ease of monitoring has also caused many users to actively conceal their identities on the Bitcoin network, which is somewhat easy to do since bitcoins are sent to an alphanumeric address that is randomly generated by a virtual wallet (more on that in a moment). This structure helps keep users anonymous by allowing them to create a new address for each transaction, which also means others can't see any previous transactions from a particular user.

While all transactions and wallet addresses are recorded in a public ledger, the keys needed to access funds are private, which ensures that only you have access to your bitcoins. Each transaction over Bitcoin is verified by a software program that generates an SHA-256 hash, which is sent to the public block chain. Once it's in the block chain, it is confirmed that the money has been left at your address. Donating hours of CPU/GPU cycles and electricity to compute these hashes in order to maintain the public ledger isn't going to attract many sane people, so part of the genius of Bitcoin is that the person who computes the newest block of the public ledger, or block chain, is rewarded with bitcoins. The people who actually do this work with their PCs are called miners, and these power users carefully calculate the cost/benefit ratio of computer hardware and electricity costs against the bitcoin exchange rate. Miners make money by exchanging their bitcoins for local currency through exchanges. We know it sounds good, and you're raring to compute some cash, so let's take a look at what you need to do to acquire some bitcoin.

Latest Transactions

91ec05643fb511e0d73d72dd5...	1 minute	1.0495 BTC
c960fab86be02dd6a62264e95...	1 minute	48.0295 BTC
30447d99740b9c044ba11b3a0...	1 minute	17.80 BTC
a15c3db5f529ea424c45d196f...	1 minute	1.9675 BTC
d6af95977895df60348c73909...	1 minute	1 BTC
f300ddc94afccd362e31fb02e...	1 minute	1.16 BTC
166e4b1b12... (SatoshiDICE 24%)	1 minute	0.178 BTC
d464330d3897466d8e2e6da86...	1 minute	0.03 BTC
e2e9cb6de42b4d6cd83954c45...	2 minutes	50.01 BTC

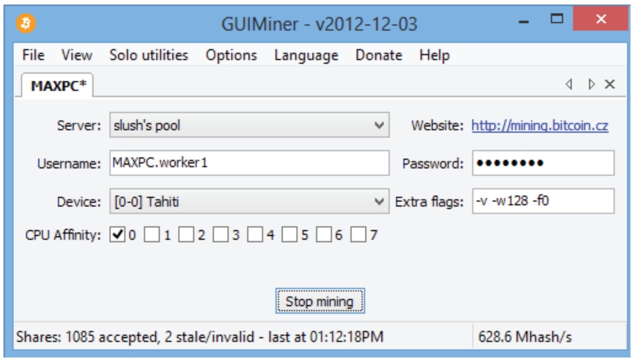
The block chain tallies all transactions, and features a ticker showing the latest payouts.

I Want Bitcoins

The most popular method of acquiring bitcoins is to mine them by crunching algorithms on a PC, but the fastest way to get them is the old-fashioned way. No, not stealing them, but buying them. If you're looking to anonymously exchange cash for bitcoins, BitInstant (www.bitinstant.com) offers a network of retail locations that let you do just that. If you're willing to sacrifice some anonymity, you can use a service such as Coinbase (www.coinbase.com), which allows you to add funds through PayPal. If you're a smooth talker and have friends in the Bitcoin community, you can always solicit them to send funds to your address, but be warned: There is no way to reverse a bitcoin transaction!

Bitcoin Mining

The more interesting way to acquire some coin, at least for our audience, is to use your PC to mine them. To get started, you register



A lightweight client that can be used with any mining pool, GUIMiner is a good way to start your bitcoin mining career.

online to either join a mining pool or start mining solo. There are dozens of popular pools, with some reaching over 30,000 users, and they are always accepting new members. You just need to find a pool and register, then download a mining program that will start crunching numbers for your pool. GUIMiner (http://sourceforge.net/projects/guiminer) is one of the most popular mining programs for new users because it's one of the few applications with a graphical user interface, so it keeps users away from the command line and will have you mining in only a few clicks. If you had to register for your pool, select your pool from the server box, insert your username and password in the appropriate boxes, then click "Start mining." If your mining pool is not listed, select Other and insert your mining pool's URL and port number.

What Kind of Rig Do I Need?

Before 2010, people were crunching numbers using their CPU; then the GPU was introduced to bitcoin mining and drastically changed the game. With its fleet of specialized compute units, GPUs crunch bitcoin many factors faster than even an Intel Core i7 CPU. As an example, a Radeon HD 7970 can reach over 700Mhash/s, whereas a GTX 680 can crunch a little more than 110Mhas/s, and an Intel Core i7 4770k can only achieve a paltry 8Mhash/s! Keep in mind, though, that one Radeon HD 7970 would take over a year to chew through a Bitcoin block, so you'll need some major firepower to increase the speed at which the transactions occur. One more problem: As more users compete to mine bitcoins, the difficultly is automatically adjusted, making it harder to mine, ensuring bitcoins are constantly mined at approximately one block every 10 minutes.

To use your GPU to mine bitcoins, you need to install OpenCL or CUDA, which are included in the latest driver packages from AMD or Nvidia, and then select your GPU in the GUIMiner device box. GUIMiner's Extra Flags box allows you to specify the GPU load you want and even the fan speed to keep things frosty. For best performance on AMD cards, we generally found "–v –w128 –f0" to be the optimal settings, and "–f0 –w128" on Nvidia cards.

ASIC Miners: The Bitcoin Specialists

An application-specific integrated circuit, or ASIC, bitcoin miner is a microchip specifically designed to run the Bitcoin calculation. These chips' physical circuits are built only to mine bitcoins, really fast. While an Asus Ares II Radeon HD 7990 can mine bitcoins at a blistering 1,420Mhash/s, a similarly priced ASIC miner can hash 25,000Mhash/s! Almost 20 times faster at the same power rating, making ASIC miners the go-to hardware for those trying to get rich mining bitcoins. There are a variety of companies designing these bitcoin mining integrated circuits, but sadly most are still vaporware, even after taking pre-orders. Butterfly Labs, Avalon ASIC, and ASICminer have managed to ship their products in limited quantities, starting at around $100 for a plug-and-mine USB model that can mine at about 300Mhash/s and going as high as $1,250 for a 25,000Mhash/s miner. But with the difficultly of bitcoin mining increasing and the high price of really powerful ASIC miners, many people are doubtful that serous money can be made, even with these specialized devices.



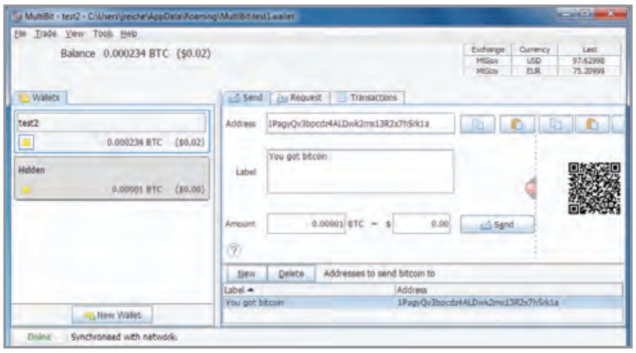
Butter Fly Lab's 5,000Mhash/s Jalapeno ASIC miner costs $275 and mines bitcoins 10 times faster than a similarly priced GPU.

Managing Your Bitcoin

Now that you've got your gear and are mining away in a pool, you had better get ready to receive your first bitcoin, and to do that you'll need to set up a virtual wallet. Since Bitcoin is all about user control, you can decide how you want to set up your wallet, so you can choose an online wallet such as Blockchain (www.blockchain.info/wallet) or an offline wallet such as MultiBit (www.multibit.org). Online wallets are the most convenient, as all your addresses and private keys are stored in the cloud, though this does leave them vulnerable to hackers and other malicious attacks. In contrast, desktop wallets are stored locally and are best for people who like to have all their data where they can see it; you just have to manage your private key files yourself.

Once you've chosen a wallet and set it up, you will then need to know your address so that you can receive bitcoin. Using MultiBit, you can simply select the wallet where you want to receive the funds, select the Receive tab, and MultiBIt will show the address of that wallet. To help people preserve anonymity, a new wallet and address can be used for each transaction by one individual, which makes tracing transactional histories almost impossible.

Spending bitcoins is just as easy as receiving them—you just click the Send tab within MultiBit and insert the alphanumeric destination address of the person or organization you are sending bitcoins to, and hit send. If you are sending X number of bitcoins, the software will display conversion rates from the biggest currency exchanges so you know the USD equivalent, and you can also specify an amount in your local currency, which is automatically converted to bitcoins by the software.



MultiBit is one of the most popular offline bitcoin wallets, thanks to its clean interface and ease of use.

> SPENDING BITCOINS IS JUST AS EASY AS RECEIVING THEM

AMD vs. Nvidia

AMD is head-and-shoulders above Nvidia when it comes to mining hardware, and that's a fact, not an opinion. Its dominance is due to two main factors: the type of algorithm Bitcoin uses, and AMD's hardware configuration. For example, the SHA-256 algorithm crunched by bitcoin miners uses a 32-bit integer right-rotate operation, something that takes later-model Nvidia GPUs (excluding Titan) three steps to do, while an AMD Radeon can do it in a single step. Mining bitcoins also favors a higher number of compute units, so AMD also has the advantage here since the Radeon HD 7970 has 32 compute units compared to the 14 SMXs in a GTX Titan.

AMD's performance advantage is so large that a $100 Radeon 7750 can mine bitcoins at about 140MHash/s, which is about 20 percent faster than a $450 GTX 680. Nvidia's flagship GTX Titan narrows the performance gap with GPU compute optimizations, but still falls behind. Mining bitcoins with a GTX Titan will give you 340Mhash/s while an Asus Ares II (Radeon HD 7990) can give you 1,420Mhash/s, over four times the performance.



Photo courtesy of Detritus

With four Radeon 6970s and two Radeon 5870s, this rig uses a custom open case to keep the GPUs cool. This monster machine hunts for bitcoins at about 2,400 MHash/s.

Getting Paid

When a Bitcoin block is completed, the 25-bitcoin reward is split among the pool miners in one of several different methods. Pay-per-Share (PPS) is one of the safest ways to pool-mine bitcoins, as the pool operator pays you immediately for each share of the block you compute. The operator pays users out of his or her own pocket before getting reimbursed for the block by the Bitcoin network. Since he or she is fronting all the virtual cash, they usually take a higher percentage fee from each block reward in exchange for assuming all the risk. Another method of compensation is named a Score pool, and it rewards you for your share of the block, but your payout is weighted by the amount of time that has passed since the beginning of the block, so with a Score pool you are rewarded for crunching the most numbers and for your loyalty to the pool. Alternatively, a Pay-on-Target (POT) pool rewards each user based on the difficulty of their compute contribution. This is an attractive pool for those with high-powered PCs. Some of the most popular mining pools include 50BTC.com (a PPS reward system), Mining.bitcoin.cz (a Score reward system), and BTCGuild.com (a variant of the PPS reward system).

Also, in order to ensure an even pace of bitcoin development, the reward amount is cut in half every four years and currently is set at 25 bitcoins a block. In the year 2016, it will be cut in half again, and that will continue until 2140, when all 21 million bitcoins will be mined and bitcoin production will stop.

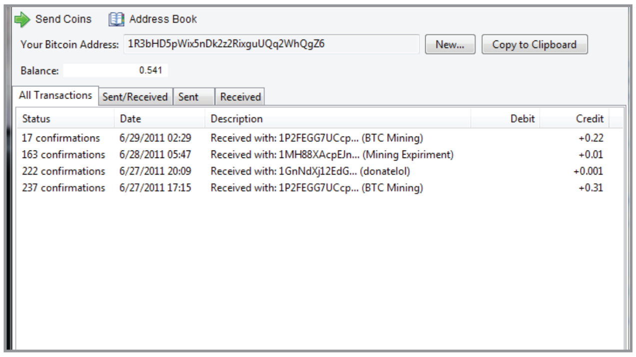


Image courtesy of Tim Verry.

Many applications allow you to see all your Bitcoin transactions and account balance.

What You Can Do with Bitcoins

Now that you have bitcoins in your wallet, you will need to know where you can spend the crypto currency. The anonymity that bitcoin offers first attracted a lot of adult and underground illicit websites like Silk Road that accepted bitcoins for payment. However, with Bitcoin gaining mainstream attention, large e-commerce sites have started accepting the digital currency, so today you can buy everything from discount flights (BTCtrip.com) to webhosting (WordPress.com). There is also a bitcoin-only marketplace named Bitmit (www.bitmit.net) and, of course, you can always donate to the Electronic Frontier Foundation (www.eff.org) with bitcoins. Paying with bitcoins is streamlined on e-commerce sites, so you just click the button labeled "Pay with Bitcoin" and you are generated a unique bitcoin address to send your payment to. At checkout, the final price shown in bitcoin is accompanied by the price in dollars, making it easy to know how much you are spending. Along with the anonymity of bitcoin, many businesses that accept bitcoin offer discounts of up to 10 percent for the using the digital currency.

The Future of Bitcoin

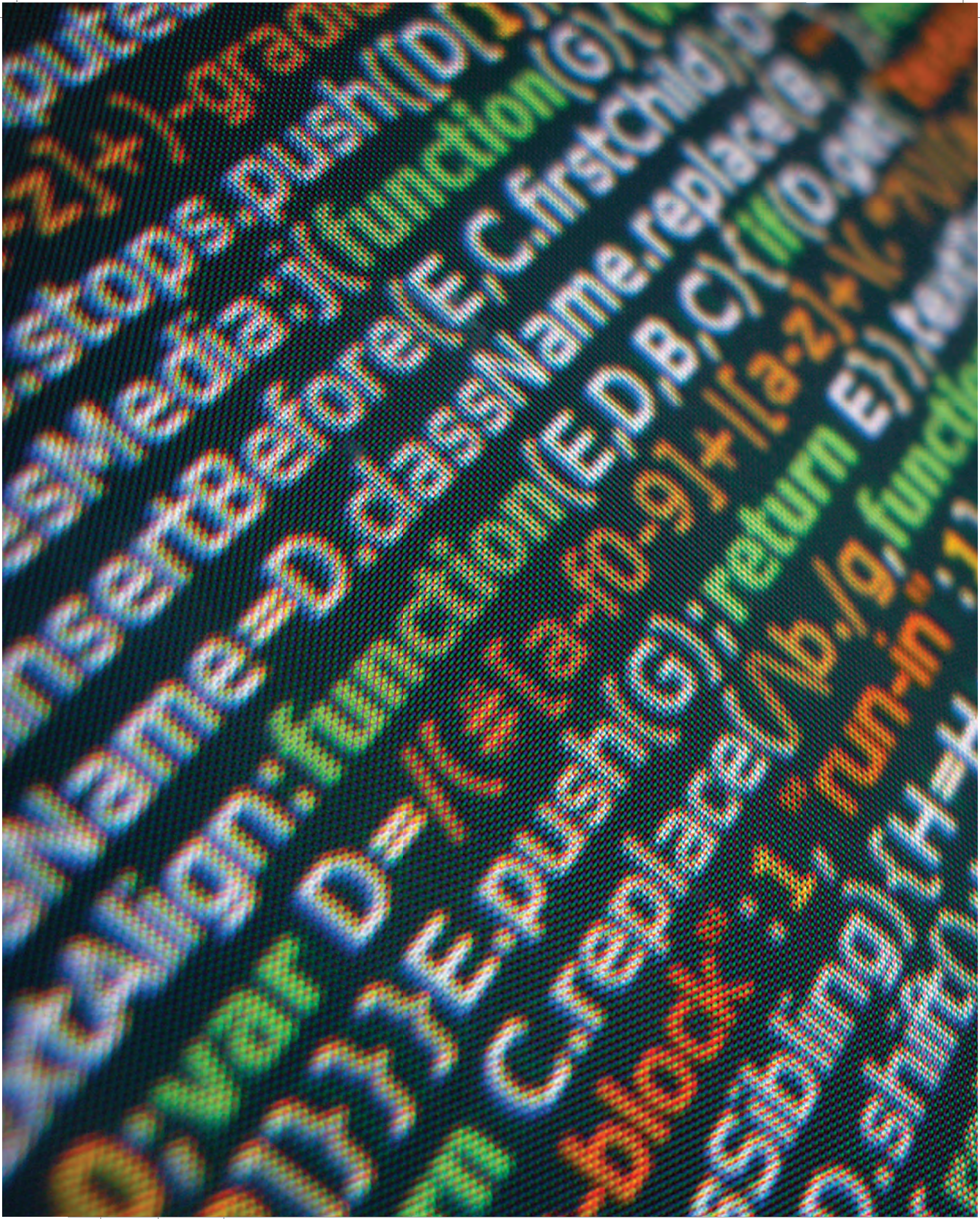
As the currency gains mainstream awareness, more retailers will start accepting bitcoins and more startups will develop services to make Bitcoin easier to use. Many believe the currency will continue to rise in value, as mining bitcoins becomes increasingly difficult and more people start to use them. Companies are also developing Bitcoin ATMs that will easily let you transfer your cash into a bitcoin wallet. Bitcoin debit cards are in the works, too, which will allow you to pay retailers by automatically converting your bitcoins to dollars.

On the hardware side, the advent of ASIC bitcoin mining boxes has made the act of using a PC to mine bitcoin a big waste of time and money, causing PC hobbyists to abandon bitcoin mining altogether. ASIC miners are so much faster that GPU miners can't compete. As the ship has sailed for GPU mining enthusiasts, most GPU miners have sold off their mining rigs or moved to a new currency named Litecoin. Litecoin is a digital currency based on Bitcoin, but it grants rewards every 2.5 minutes as opposed to the 10 minute average interval for Bitcoin. More importantly, it's much harder to create ASIC litecoin miners and none exist so far.

Like any other phenomenon that goes from underground to mainstream, so goes Bitcoin, and as it does, companies will try to profit from Bitcoin and enthusiasts will move to newer, cooler crypto currencies.



Lamassu is a company offering Bitcoin ATMs that convert cash to bitcoins and deposits them in your bitcoin wallet.





Cracking the Code

Every PC user should know how to program, and there's never been a better time to learn

BY ALEX CASTLE

WITH THE HUGE variety of computing devices all around us, it's important to remember what it is that's special about a full-fledged personal computer. We think the main difference can be summed up in one word: mastery. No matter how much time you spend with an iPad or an Android phone or in a web browser, you can never truly master it. There's just not enough there to learn. But the PC? That's different. The PC goes *deep*.

As you develop your mastery over the PC, you move past all sorts of boundaries. First, you learn to replace the software that came on the computer. You discover the command prompt and how to tweak the OS. You learn to build your own PC, and to benchmark it. And then, at the very bottom of it all, there's one last boundary standing between you and true PC mastery. You have to learn to program.

Why is coding the ultimate test of PC mastery? Because learning how to program is the thing that breaks down the wall between you and your computer—it makes it possible for you to truly understand what's going on underneath your desktop.

And, all philosophical ramblings aside, it's a pretty great skill to have. Whether you need to automate a process on your computer or whip up a quick web app for a family member's website, knowing how to code is a big boon. Who knows, you might even be able to earn some money.

Learning to program isn't something you can do in an hour, or even in an afternoon. You have to learn to think in a whole new way, which takes dedication and patience. Fortunately, it can also be a lot of fun. In this article, we're going to take a whirlwind tour through some of the most important concepts in programming, and we'll direct you to resources that'll help you start your adventures in coding.

BASIC INFORMATION

A Q&A ON THE ABCs OF PROGRAMMING

Before we can do anything, we've got to cover the basics. Here's what you have to know before you can get started.

WHEN WE SAY "PROGRAMMING," WHAT DOES THAT REALLY MEAN?

For this article, we're going to use a fairly narrow definition of programming, and say that what we're talking about is the process of creating software on a computer. That process involves writing out a series of commands for the computer to execute, which will create our desired behavior. We write those commands using a programming language.

WHAT'S A PROGRAMMING LANGUAGE?

A programming language is the set of rules that define how we express what the computer should do when it executes the program. There's an incredible variety of programming languages available for use, but the vast majority of commercial and personal software is written in one of a core group of languages including C/C++, Java, C#, Python, and a few others. Modern programming languages share a lot of the same basic concepts and some syntax, so learning your second, third, or fourth programming language is much easier than learning your first.

WHAT MAKES ONE PROGRAMMING LANGUAGE DIFFERENT FROM ANOTHER?

Each programming language has its own strengths and weaknesses. C and C++ are *low-level* languages, meaning that code written in C is closer to the *machine code* that your CPU understands (see sidebar below). Low-level languages can produce faster, more efficient software, so they're used where performance is at a premium—for programming an operating system or a 3D gaming engine, for instance. *High-level* languages, like Java and Python, have the advantage of being much easier to program in, and the same program can generally be written with fewer lines of code in a high-level language.

BUT WHICH ONE'S THE BEST?

There's no one best language—it really depends on what kind of programming you want to do. If you want to program native Windows applications, you'll use C#; if you want to program sophisticated web applications, Ruby would be a good choice; if you want to be the next John Carmack, you should probably start with C.

NO, FOR REAL, WHICH LANGUAGE SHOULD I START WITH?

The secret is to not stress too much about whichever particular language you start with. The important things you will be learning are all basic concepts that work pretty much the same in every programming language. You'll learn how to use data structures and conditionals and loops to manage how your code flows. You'll learn to structure your program in a way that's readable and organized. Once you've done all that, learning a bit of syntax to pick up a new language won't seem like much work at all.

But, if you really want a suggestion, start with JavaScript. It's an easy language to learn, it's got some practical applications, and its syntax is similar enough to some more-powerful languages like C# and Java that making the transition later on won't be too hard.

IS HTML A PROGRAMMING LANGUAGE?

Not quite! HTML is a markup language, used to define the contents of a webpage. Although HTML has a specific *syntax* (a set of rules defining how you have to write things), it doesn't have *semantics*, or meaning. An HTML document is *rendered*, rather than *executed*. That said, if you have written an HTML document, you at least have experience writing a formalized computer language, which may make the jump to programming easier.

How Does It Actually Work?

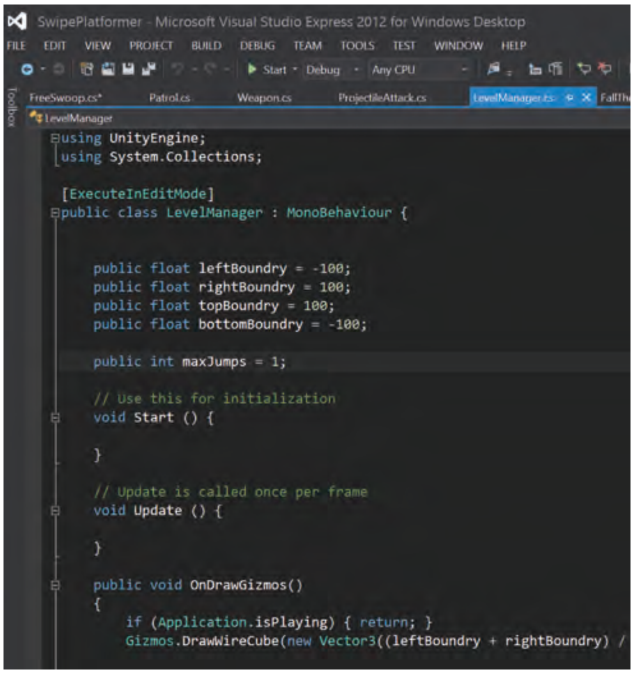
When you write a program in a high-level language like JavaScript, the document you create isn't something that your computer's low-level hardware can understand. The CPU has only a limited number of instructions it can perform, such as addition, subtraction, and moving numbers into and out of memory. These instructions are actually physically implemented in the CPU using transistors organized into *logic gates*. Though modern instruction sets, such as the X86-64 set implemented in any consumer 64-bit CPU, are actually very large and sophisticated, programming for the CPU directly (using a super-low-level language called *assembly language*) is an arduous, slow process.

High-level languages allow you forgo a lot of the technical grunt work. For instance, in a high-level language, you can simply declare and use variables as you please, without ever worrying about what exactly is going on in your system's memory. In assembly language, you have to manually assign data to locations in memory as you use it, and clear up the memory when you're done.

In order to get your high-level program to run on the CPU, you need a *compiler*—a piece of software that optimizes your code and converts it into a machine-readable executable file. Some languages, such as Java, are not compiled, but rather *interpreted*, which means that the source code itself is distributed, and then compiled on the end user's machine. The upside of an interpreted language is that you can distribute a single file that can be run on Windows, OSX, or Linux. The downside is that whoever runs the file has to have a copy of the interpreter on their machine—an annoyance that anyone who's tried to run a JavaScript applet on a new computer will be familiar with.

WHAT'S AN IDE?

An IDE (short for integrated development environment) is the software suite programmers use to actually write programs. They generally include a specialized text editor for writing the source code, as well as the ability to test and debug your program. Two of the most popular IDEs are Eclipse (open source, free, and available at www.eclipse.org) and Microsoft Visual Studio (proprietary and expensive, but with a free "Express" version that's limited to and excels at programming in C, C#, and BASIC).



Visual Studio is one of the most advanced IDE's around, and is used by nearly all Windows programmers.

HOW CAN I START WRITING A PROGRAM, LIKE, RIGHT NOW?

Unfortunately, it can be a bit of a hassle to get started coding in most programming languages. You generally have to install and configure an SDK (software developer kit), and sometimes an IDE as well, in order to be able to write and compile code in a new language. It's rarely super hard, but be prepared to spend 15–30 minutes Googling, reading a guide for your chosen language, and setting things up.

Fortunately, JavaScript is much easier to get started with. In fact, you can start writing code right this second, using an in-browser coding environment like JSFiddle.net. An in-browser IDE isn't a good solution for serious programming projects, but it's a great way to get started as a beginner. To start writing JavaScript in an interactive environment with structured lessons, you can visit www.codeacademy.com (but more on that later).

170 Years of Programming

THE MOST IMPORTANT MILESTONES IN CODING HISTORY

1842 – THE FIRST PROGRAMMER

Ada Lovelace, daughter of the poet Lord Byron, diagrams a sequence of punch cards representing an algorithm for Charles Babbage's Analytical Engine. Though the machine was never completed and the algorithm never ran, the diagram is considered to be the first computer program in history.



1954 – THE FIRST MODERN PROGRAMMING LANGUAGE

FORTRAN, the first high-level programming language, allows programmers to describe equations with drastically shorter programs. 50 years later, FORTRAN still sees widespread usage in the fields of mathematics and science.

1978 – THE BIRTH OF C

Ken Thompson and Dennis Ritchie publish their book introducing the C programming language, which would go on to become one of the most-used languages of all time, and to have a strong influence on many of the programming languages in use today.

1995 – THE FIRST LANGUAGE OF THE WEB

Sun Microsystems releases the first version of the Java programming language. The language took off in part because of its integration with early web browsers, and remains one of the most popular programming languages in the world to this day.

Java

CORE CONCEPTS

UNDERSTAND THESE, AND YOU'VE GOT EVERYTHING YOU NEED TO START WRITING PROGRAMS IN ANY LANGUAGE

VARIABLES

Variables in programming are a little different from the "X"s you remember from high school algebra. In programming, a variable is like an empty container—it can hold a number, a word, or any other data or data structure you want to use in your program. The program can read and change the variable's value as it runs, letting you keep track of and manipulate data.

Variables are the basic building block of a program, and most lines of code in any program will include a variable in some form.

In some languages, such as Python, a single variable can contain one type of data (say, a number), then can be assigned to hold a different type of data (like a word). In other languages, such as C and C#, a variable is *declared*, with a particular type, and then can only hold that type of data for the rest of the program. This is the distinction between *dynamically typed* and *statically typed* programming languages.

CONDITIONALS

Most programs do not run in a vacuum—they accept some form of user input. To deal with the uncertainty that this brings, we need to be able to write code that is flexible, and to do that, we need conditionals.

Conditionals are places where the code branches. In most modern languages, they take the form of an *if statement,* which joins an expression that is either true or false (called a *Boolean expression*) and a block of code. The if statement says, in a nutshell, "If this Boolean expression is true, execute the following code. Otherwise, skip it."

In most languages, if statements can also include an *else* clause, which allows you to specify a second block of code that will only be executed when the Boolean expression is false. For example, on the opposite page, the 99BottleOfBeer function includes an if statement that checks to see if the "age" variable is greater than or equal to 21, and sets a different variable called "drink" to an age-appropriate libation.

LOOPS

Another way you can control the order in which code is executed is with a *loop*. Where an if statement allows you to execute or not execute a certain block of code, a loop allows you to keep executing the same block of code multiple times.

There are several different types of loops, but the two that you'll find in almost any programming language are the *while loop* and the *for loop*.

A while loop works a lot like an if statement. You attach a Boolean (true or false) statement to the while loop, and as long as that statement is true, the loop keeps repeating. Basically it says "as long as this statement is true, keep going." As a consequence, something inside the looping code has to make a change that could cause the Boolean statement to become false, or else the loop will never end.

For example, the following code will print out the word "hello" 10 times, then stop:

```
while(x < 10) {
    x = x + 1;
    print("hello");
}
```

Notice that we used the variable x as a loop counter, to control the number of times the loop runs. The other most common type of loop, the for loop, is basically just a while loop with a built-in loop counter. You tell the loop right away how many times you want it to run, like this:

```
for(int x; x < 10; x = x + 1) {
    print("hello");
}
```

The part after "for" just defines a counter. It says "start with a number (integer) we'll call x, and keep looping as long as x is less than 10. At the end of every loop, increment x by one."

FUNCTIONS

The most powerful way to control the flow of a program is with *functions*, which allow you to reuse code. Also called a *subroutine*, a function is a block of code that you've given a name to, so you can reuse it any time you want.

For example, you could define a function called PrintHelloThenGoodbye by doing the following:

```
void PrintHelloThenGoodbye()
{
    print("hello");
    print("goodbye");
}
```

Then, if you called that function three times in your code, as follows:

```
PrintHelloThenGoodbye();
PrintHelloThenGoodBye();
PrintHelloThenGoodbye();
```

Your program would output "hello goodbye hello goodbye hello goodbye."

A function can also take variables as inputs, and *return* an output value. So, for instance, you could write a function that takes a number as an input, and returns that number squared. It would like look like this:

```
int Square(int toSquare)
{
    return toSquare * toSquare;

}
```

Notice the "return" keyword. That passes the following value back to whatever part of the code called the function. So, if somewhere else in the code we called the function like this:

```
print(Square(5));
```

The program would print out the number 25.

Sample Code

This oh-so-practical program prints out an age-appropriate version of the song "99 Bottle of Beer."

```
function 99BottlesOfBeer(int age) {

    var bottlesLeft = 99;
    var drink;

        if (age >= 21) {
            drink = "beer";
        } else {
            drink = "coke";
        }

        while (bottlesLeft > 0)
        {
            print (bottlesLeft + " bottles of "
            + drink + " on the wall");
            bottlesLeft = bottlesLeft - 1;
        }
}
```

SYNTAX

Maybe the most intimidating thing about programming is the syntax—the strange punctuation marks and cryptic words that make a page of code look like a foreign language. Fortunately, in most programming languages, syntax is really only a couple of rules that you have to remember, and a lot of syntax is shared between languages.

It's all dependent on what language you're programming in, but here are a couple of syntactical elements that are common across many popular languages:

SEMICOLON The semicolon is like the coding equivalent of a period—each line of code ends with one. It's important, because in many languages, line breaks are just for readability, and don't have any effect on the execution of the code.

PARENTHESES Parentheses are used after functions (see above) to contain that function's parameters (or inputs). You might remember this usage from your high school math classes, when f(x) was a function that operated on the variable x.

CURLY BRACES In a number of languages (particularly those derived from C), curly braces "{}" are used to enclose and group blocks of code. They're used, for instance, after the control structures described on these pages (if statements, loops, and functions), to designate the block of code that the statement refers to.

INDENTATION Because all of the control structures can be nested inside each other, code tends to take on a sort of hierarchy. A particular line of code might be inside an if statement, which is inside another if statement, which is inside a loop that's inside a function. All that can get hard to keep track of! To make it easier, code is written with variable levels of indentation. The more indented a line of code is, the more deeply nested it is. In most languages, indentation is purely for readability, but in a few (like Python), it actually controls the grouping of code, and is used instead of curly braces.

ADVANCED COURSE: OBJECT-ORIENTED PROGRAMMING

TAKING A LOOK AT THE BIGGER PICTURE

Using only the tools we've discussed so far, you can write functions that manipulate variables in all sorts of ways—the foundation of pretty much any program you want to write. Unfortunately, as the complexity of a program increases, it becomes difficult to maintain code that's organized and easy to understand using only those concepts. As an example, if you were writing code for a bank to keep track of its customers' accounts, you would quickly end up with hundreds of functions and thousands of variables. It would become very difficult to understand what was going on in the code at any particular place, and more generally how the whole thing *works*.

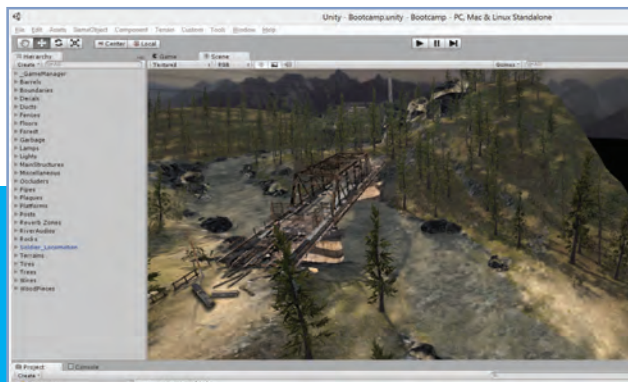
That's what object-oriented programming (OOP) is for. OOP is a *paradigm* that allows you to group variables and functions together into *classes*, which are (usually) meant to model things or particular concepts. For instance, in the bank example, we might start by creating a class called "Account," which simulates a user account. Classes are made up of variables and functions (called *methods* when they're part of a class), so we start by figuring out what data (variables) and capabilities (methods) an account needs to have. For variables, we might use account number, the account holder's name, and the balance. For methods, we would want the ability to deposit money, which would increase the balance variable, and withdraw money, which would decrease it.

Once you've *defined* a class, you have to *instantiate* it for every object you're modeling. So in the bank example, we would create a new instance of the account class for every customer of the bank—that way every person can have his or her own account number and balance.

It all sounds very complicated until you get to play around with it yourself, but the basic idea of OOP is that we set up a system of tens, hundreds, or thousands of objects that can cooperate with each other to produce the effect that we want.

Object-oriented programming is not the only programming paradigm in use, but it is the most common. Understanding the core concepts of classes, objects, and methods is the last hurdle to programming in languages like Java, C#, and Python.

> “OOP IS A PARADIGM MEANT TO MODEL PARTICULAR CONCEPTS



The free Unity game engine combines a drag-and-drop 3D interface with JavaScript and C# scripting.

Next Steps

HERE ARE TWO WAYS YOU CAN GET STARTED MAKING SOMETHING COOL

UNITY

If you don't pay much attention to the game-development scene, you might never have heard of Unity, the game engine that's quietly revolutionizing indie development. What's so good about it? Two things: First, Unity is a flexible and powerful engine for making 3D and 2D games. Unity takes care of all the low-end graphics and physics processing, so you can focus your coding energies on the high-end gameplay decisions. You can code in JavaScript or C# in Unity, and it can automatically build your game for you on almost any platform, from the PC to the PlayStation to the iPhone.

Second, and perhaps more amazingly, Unity is available to everyone for free. Where previously a high-quality game engine would have to be licensed for tens of thousands of dollars, Unity lets you code professional-quality games for free. There are a few features that you have to pay for, but the free versions should still have all the tools you need.

To get started with Unity, visit **www.unity3d.com** and download the free IDE. There are plenty of great resources for learning to use Unity online, and the IDE comes with an extensive sample project and tutorial.

EDUCATE YOURSELF

LEARN TO CODE AT YOUR OWN PACE WITH THESE GREAT ONLINE RESOURCES

On the previous pages, we talked a bit about semantics, syntax, and structure, the three things you need to write code. If you were able to follow along, you already know enough to start writing simple programs, and you can pick up the rest as you go. If it still seems a little murky, don't worry—programming is the kind of thing that really only clicks when you try it yourself. Here are some tips for getting your feet wet:

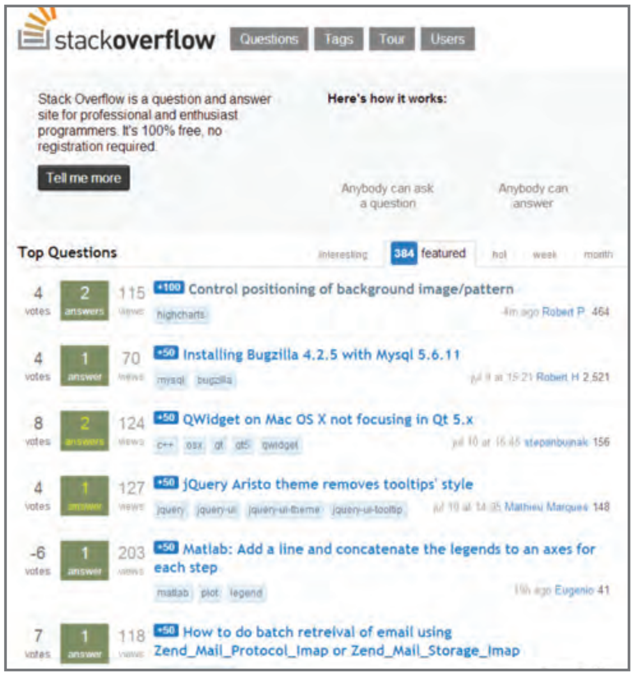
USE CODEACADEMY

CodeAcademy is the best resource there's ever been for complete beginners to learn coding. It's a series of interactive tutorials that teach you the fundamentals of programming, one bit at a time. In each lesson, you'll write actual code that compiles and runs right in your browser, and the lessons build on each other gradually enough that you'll rarely feel out of your depth.

You can learn a number of languages at CodeAcademy, including JavaScript, Python, and Ruby. It won't teach you everything you need to know to be a professional coder, but it will give you the basic familiarity with the language that you need in order to start learning more complicated concepts.

USE STACK OVERFLOW

Once you've gotten started with a language, the programmer Q&A site StackOverflow.com is the best repository for answers about more complicated topics. Don't start asking questions right away (someone has almost certainly asked about anything you're running up against), just use the search function to find answers related to any problems you have.



It's not the most newbie-friendly site on the web, but Stack Overflow is an unparalleled resource for programmers.

USE GOOGLE

Of course, Google is great for solving almost any sort of problem, but it's especially good for issues related to programming. Maybe it's because the people who tweak the Google search engine are programmers themselves, but Google is excellent at picking out relevant pages from various programming languages' documentation.

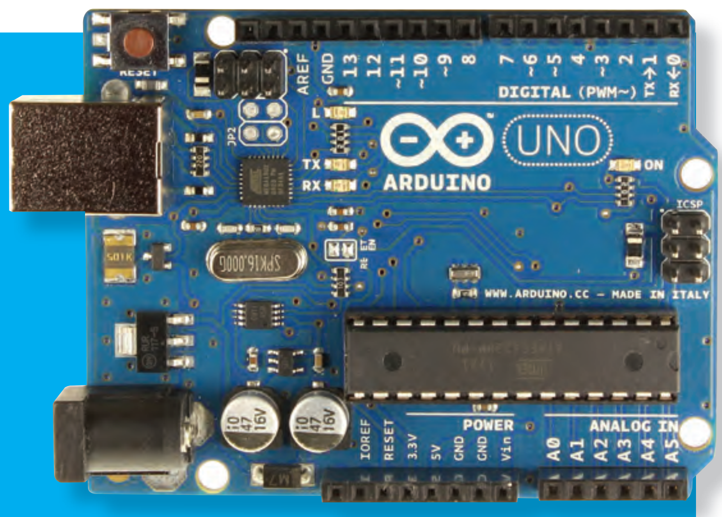
Ultimately, the key to learning to program is to not let yourself get overwhelmed. Hopefully, the concepts we've covered in this article have been enough to pique your interest, but don't worry if it's still a little confusing. Take your time, make use of the online resources available to you, and you'll have conquered the final frontier of PC power-use before you know it.

ARDUINO

If physical projects are more your thing, you can write programs that control devices in the real world, using a microcontroller like Arduino or Raspberry Pi. These microcontrollers feature small, inexpensive processors and can be programmed from your computer. By wiring the microcontroller to electronics including motors, sensors, and lights, you can build anything, from a robot to a sous vide machine.

Arduino in particular has an excellent collection of documentation and tutorials. You can find a basic Arduino UNO board at Adafruit.com, Sparkfun.com, or Makershed.com for as little as $25-$30, and you can download the IDE (which comes with a whole load of sample scripts) at www.arduino.cc. The IDE uses the C programming language, which is more difficult than JavaScript, but the documentation is good and the actual programming required for Arduino projects tends to be very straightforward.

So, what are you waiting for? Get out there and start making something!



An Arduino board features a microcontroller chip, along with input and output ports to hook it into any project.

iFixit presents:

AUTOPSY

THIS MONTH WE DISSECT...

Samsung Galaxy S4



About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.



BACKGROUND:

While the Galaxy S4 offers notable improvements in display, features, and processing power over its popular predecessor, the basic design is very similar, if not identical, to the Galaxy S III—which is a good thing, since that device is pretty fixable.

MAJOR TECH SPECS:

- 5-inch display with 1920x1080 res, at 441ppi
- 16-, 32-, or 64GB of internal storage, expandable with up to 64GB of external microSDXC storage
- 2GB RAM
- Qualcomm SoC with 1.9GHz quad-core proc
- 13MP rear-facing camera and 2MP front-facing camera
- Lithium-ion battery rated at 3.8V and 2600mAh (9.88Wh)

KEY FINDINGS:

- The back panel is as easy to remove as they come—a fingernail in the groove and the phone opens to reveal the removable battery.

- The mid-frame is held into place by a few screws and a few clips that can be released with a plastic opening tool.

- With the midframe off, several connectors and a single screw are all that hold the motherboard in place. The front and backside of the motherboard hold all manner of chips, for communications, power management, memory, etc., as well as the 1.9GHz Snapdragon quad-core CPU.

- After removing the headphone jack, status LED, IR sensors, and 2MP camera from the front of the device, we're able to extract the remaining, slightly adhered parts filling the Galaxy S4's display assembly: a multi-purpose component that connects the earpiece speaker, IR blaster, and a sensor array; a linear oscillator vibration motor; and a daughterboard with a full-featured micro-USB port capable of HDMI output, connecting USB peripherals, and charging and transferring data.

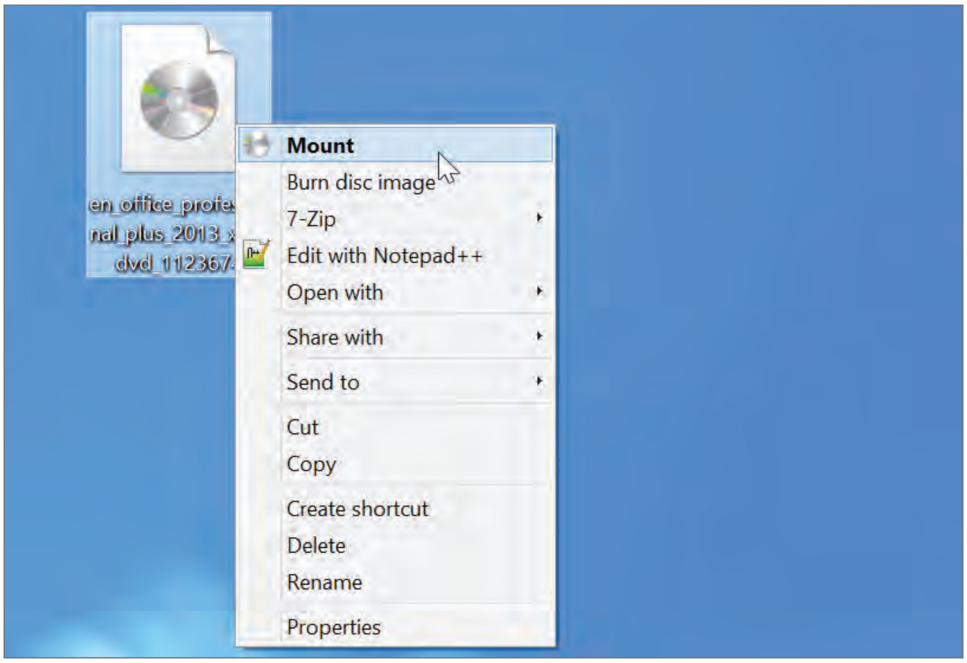
- The display and front glass are fused with a layer of optical adhesive. The glass is then adhered to the plastic display frame, making a single assembly.

- Repairability score: 8 out of 10. The battery can be replaced in seconds, without any tools; easy access to internals—only 11 screws in the entire device, all standard Phillips #0; most smaller components are modular and can be replaced individually. You'll have to go through the entire phone in order to replace the front panel, since everything is built into the back of it.

HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

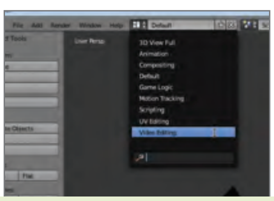
WINDOWS TIP OF THE MONTH



MOUNT ISO FILES IN WINDOWS 8

A nice feature of Windows 8 is that you can mount ISO (disc image) files without using a program like Daemon Tools. Just right-click the file and select the bold Mount option. If for some reason that option isn't there, choose Properties instead, and make sure that File Explorer is set as the default application to open files of this type.

MAKE - USE - CREATE







ALEX CASTLE
CONTRIBUTING EDITOR

KEEPING A NEW PC NEW

I RECENTLY switched over to a new laptop, and though I'm very happy with it, it's causing me some anxiety. Why? Because I know that as soon as I let this computer stop being "like new" it's never going to feel that way again. Even a reformat down the line can't ever totally restore that feeling of cleanliness you get with a computer that's never known the indignities of malware, a full hard drive, or slow boot times.

Here are the two simple things I'm resolving to do to keep this computer in top shape:

> Not install software I don't need. This is especially hard for me since I write about software, but all those tiny, harmless-seeming apps add up. If I absolutely have to try out an app that I don't plan on using regularly, I'm going to do it in a virtual machine.

> Not let anything stay on the desktop. Seriously—it's not a dumping ground, and it's way more useful as a temporary (and I mean actually temporary) storage area.

Seems pretty simple, right? Something tells me it'll be harder than I think.

↘ submit your How To project idea to: comments@maximumpc.com

Edit Video in Blender

YOU'LL NEED THIS

PLENTY OF STORAGE
Like with any high-quality video-editing software, Blender needs a lot of drive space to work with.

BLENDER
The open source 3D Modeling suite is available at www.blender.org.

BLENDER, available for free at www.blender.org, is the best-known open-source 3D-rendering software around. However, it's not only useful for 3D modelers—it actually has a built-in nonlinear video editor, as well.

If you're willing to stumble around a complex interface, the flexibility of Blender's editing capabilities is its clear advantage over other free options like Windows Movie Maker. –NEIL MOHR

1 DECIPHER THE BLENDER INTERFACE The biggest stumbling block for general Blender use is coming to grips with its crazy, nonstandard interface. It's set up for super-slick 3D manipulation using a mouse in a very unusual way.

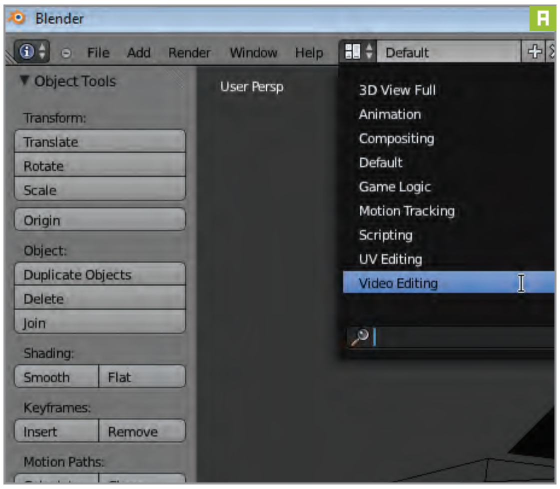
» The key thing to get your head around is that tracks are selected with the right mouse button. Doubly odd is that, if you're moving tracks, to then drop them you use the left mouse button, not the right. It's possible to zoom in and out of most panels using the mouse wheel and to scroll using the super-slim scroll bars at the edges of certain panels.

» Aside from the interface, it also turns out to be important that you set the base Properties to the correct frame rate to match your video. If you don't, the audio and video won't sync correctly. The smart thing about Blender is that it supports the audio, video, and image formats you need it to. For video that's primarily AVI, MP4, and MOV; for images it's JPEG, PNG, and GIF. Audio as part of videos can be a wide range of standard formats such as MP3, AAC, FLAC; for audio-only files, Blender oddly only supports 16-bit WAV. Getting standard video into Blender is just a simple drag-and-drop away. Using the master timeline at the very bottom, you're able to play and pause the footage. The scratchpad here makes it easy to jump to or run through a small section of footage.

» To get started on your first video, enable Blender's predefined video-editing mode. To do this, locate the upper-most menu bar, then click the menu to the right of the Help menu and select Video Editing (**image A**).

Going clockwise from the top-left, the first thing you'll see is the Graph Editor, which we'll use for audio fades. Next is the main Video Sequence Editor, and below is the strip timeline where the various audio and videos segments are shown. At the bottom is the master timeline. Note that Blender places each panel's menu at the bottom, and you can maximize/minimize any by pressing Shift + Spacebar.

» If the menu strips are too long, you can scroll them with the middle mouse button. As you add video clips these are selected with the right mouse button, using Shift + right mouse to multiselect them. The scale-like strips running along panels double as scroll bars; enlarge these vertically by dragging the tiny dot at the end of the bars.



2 START EDITING VIDEO Before importing video, set Blender to the correct resolution and frame rate, or else it will drop frames from your imported clips. Click the bottom-left icon of the Graph Editor and select Properties (**image B**). Under Dimensions ensure Frame Rate matches your video, probably 29.97fps, and check the Resolution—this will likely be either 1280x720 or 1920x1080. Then drag it onto the timeline.

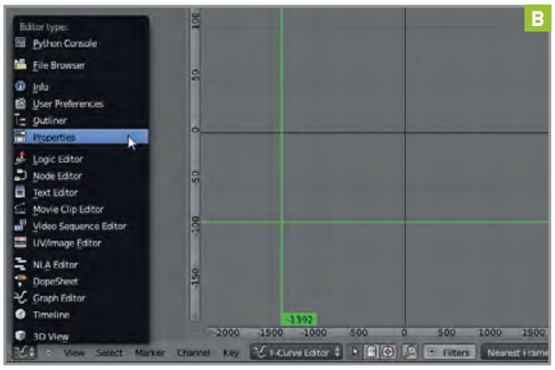
» At the very bottom, open the Sync Mode and choose AV-Sync. Play the video with the controls to the left. Left-click and drag the master timeline (scratchpad) at the bottom to scan your video. The green strips are audio, blue are video, yellow are effects. Hover the mouse over the left edge of the video preview panel and you're able to drag and resize it—use the mouse wheel to enlarge the preview.

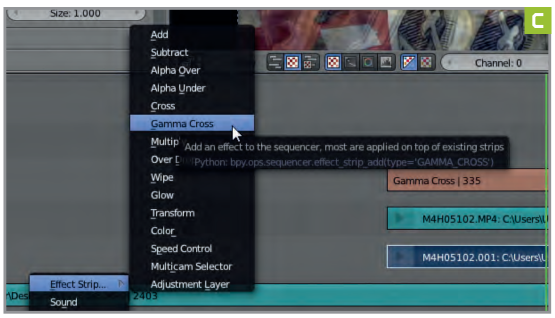
» Open the Add menu at the base of the main timeline. You can easily delete strips by pressing the Delete key. Each strip has a start and end handle, which you can grab and drag to clip the strip. You can also duplicate strips with Shift + D. Press B to enable a drag-and-drop multiselect box. To split video, press K—this uses the clip system. Press Shift + K to hard split the clip.

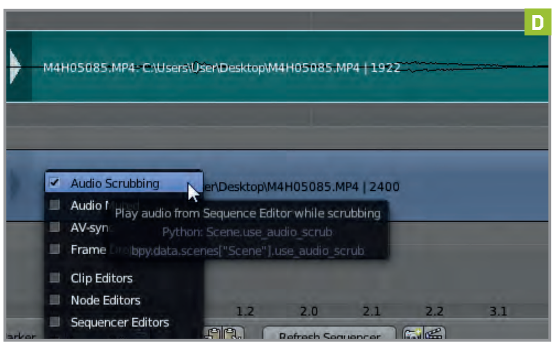
» To add a second overlapping bit of footage, you will need to press Shift and right-click the first and then second video strip, select the timeline and click Add > Effect > Gamma Cross (**image C**). This will add a basic fade transition between the two clips. Press N to see the Properties. Fading the wrong way around? Select the effect strip, open the timeline Strip menu, and select Swap Inputs.

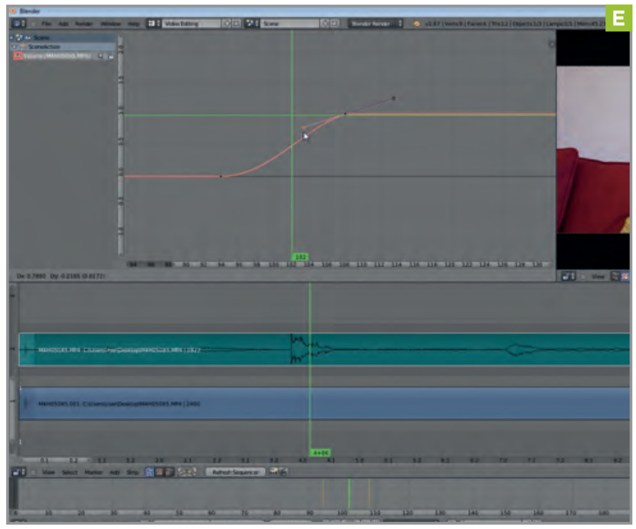
» Default scrubbing ignores audio—you can turn this on using the master timeline. You can do this by selecting Playback > Audio Scrubbing (**image D**), so audio is also previewed. Select an audio strip, press N to open the Properties, scroll down to find Sound, and check Draw Waveform to add a waveform to the timeline.

» Audio fades are generated via the Keyframe system. Select the audio strip required and cue up the start point, set the volume level via Properties, and with Volume selected, press I. Now, cue up the end point for the fade and follow the same process. Markers for the start and end will appear in the master timeline and the Graph Editor (**image E**).







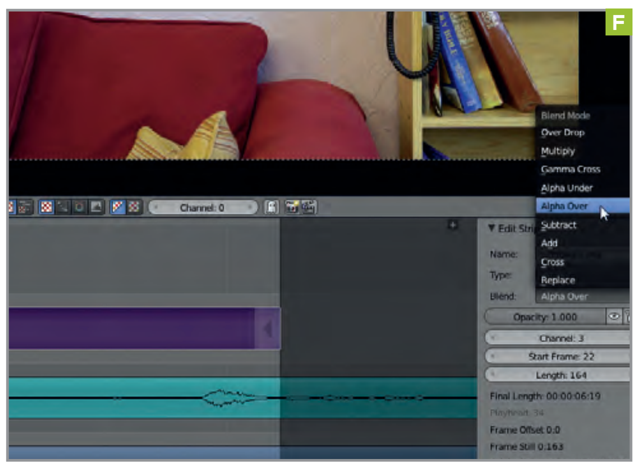


3 **ADD TITLES AND RENDER** Titling in Blender has to be done via your own created images. In GIMP or Photoshop, create a correctly sized image with a transparent background. Drop this into Blender, press N to view the Properties, and select Blend > Alpha Over (**image F**) to create the transparency. Farther down the properties, adjust Multiply for a see-through effect—you're able to adjust color and intensity here, too.

» Using the keyframe system, create a scroll effect for the title. Select the image strip and move to the start, locate and select Image Offset in the image Properties, left-click Y, and drag right to move it offscreen, then press I to create the keyframe. Drag the scratchpad toward the end of the image strip, move the logo down, and press I to scroll the text down on screen.

» To output, change the top-left Graph Editor section back to Properties by selecting its icon in the bottom-left of the panel. Scroll down to Output, change PNG to a suitable video format, ideally H.264, select RGB output, format to H.264, and audio to MP3. You'll find that Blender isn't the fastest rendering option around. Even a short clip is going to take a while to complete.

» Under Ouptut is the output file directory folder, so point this to your preferred location. Before you render, scroll to the top, ensure End Frame is set to the correct end frame of the video, drag the scratchpad to the last frame and this figure will be displayed at the bottom, next to the video controls. Finally, click Animation to render your video sequence.



Benchmark Your PC with SiSoft Sandra

YOU'LL NEED THIS

SISOFT SANDRA
Download the Lite version for free at www.sisoftware.net.

DEPENDING on your level of PC devotion, benchmarking might not be your idea of fun. Still, even if you're not a master overclocker, it can be worth it to run some quick benchmarks, just to make sure your system is working properly and that your machine's performance hasn't drastically fallen off.

The key to benchmarking is the software that you're actually using to test your system. There are plenty of neat little tools and utilities that you can use to make sure that the individual components of your rig are up to speed, but for quick-yet-comprehensive benchmarking, an all-in-one tool is most convenient.

Thankfully, there is a suite of utilities that has been a mainstay of the benchmarking world for several years, and that suite is SiSoftware Sandra. It offers the ability to check the performance of your machine for free, if you're just planning to use it for your own personal information (which we'll assume you are). Let's get started. –ALAN DEXTER

1 DOWNLOAD AND INSTALL SISOFT SANDRA First, you'll want to grab the latest version of Sandra. Head over to www.sisoftware.net, click Download & Buy at the top of the page, select Download at the bottom of the Lite column (**image G**), and then click the 64-bit X64 option from the Microsoft Windows Platform list.

» Now, you need to pick a trusted hosting site to download Sandra from. These are all respected sites, so select any of them and your download will begin. Once the program has downloaded, launch it and select the default installation options. Finally, click "Launch Sandra at the end of the process."

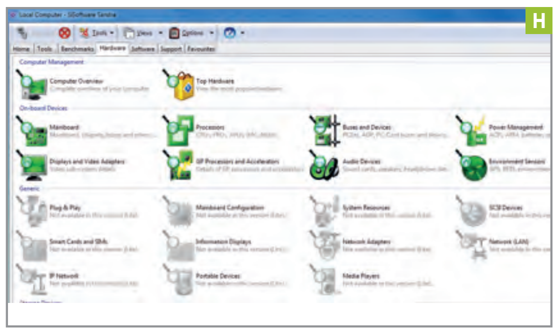


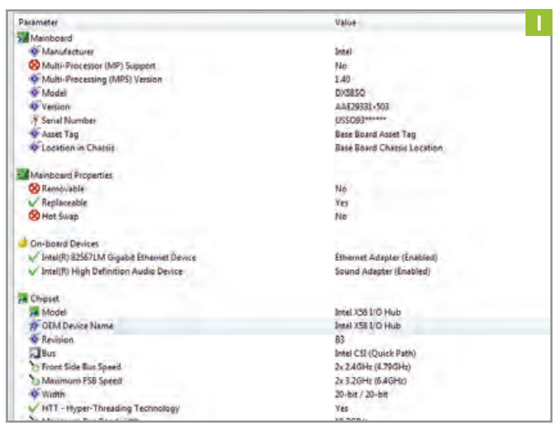
Sandra Type	Lite (Free/Gratis/Eval)	Personal	Business	Tech Support (Engineer)	Enterprise
Commercial Product (not evaluation)	✗	✓	✓	✓	✓
Suitable for Business Use	✗	✗	✓	✓	✓
Designed for Home Users	✗	✓	✗	✗	✗
Works on Domain	✗	✗	✓	✓	✓
Works on Workgroup	✓	✓	✓	✓	✓
Can remote push install	✗	✗	✗	✗	✓
Licence allows commercial exploitation	✗	✗	✗	✓	✓
Licenced per computer	✗	✓	✓	✗	✓
Premium support	✗	✗	✗	✗	✓
Licenced per user / technician	✗	✗	✗	✓	✗
	Download	Details	Details	Details	Details

2 SCOPE OUT YOUR HARDWARE Start by looking at the hardware reports Sandra creates after analyzing the components in your system (**image H**). This is useful for spotting driver incompatibilities or for spotting conflicts on older systems, but it's still a good starting point before hitting the benchmarking sections. Click Hardware to see a list of supported hardware reports.

» Your motherboard is a key component, as it's responsible for making sure everything else works together. To get the lowdown on your mobo, click the Mainboard option in the On-board Devices section. After a quick bit of scanning, you'll be presented with a long list of the key components of your motherboard, including the chipset (**image I**).

» Scroll down farther for information about the memory installed in your system. Here, for instance, we find that we have three DIMM slots occupied—banks 0, 3, and 6—and each one has a 2GB stick of DDR3 running at 532MHz. Scrolling down more reveals that the memory is made by Patriot Memory and is rated at 533MHz at 7-7-7-20 timings.





START BENCHMARKING How does this memory performance stack up against every other system out there? This is where Sandra's benchmarking tools step in. Close your motherboard report and click Benchmarks. Scroll down until you get to the Memory Controller subsection and then double-click the Memory Bandwidth icon (**image J**) to launch that module.

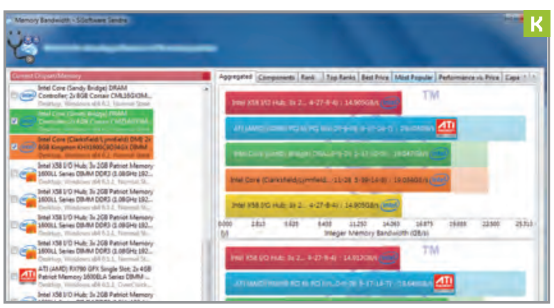
» To run the benchmark, you simply need to click Refresh—the icon made up of two blue arrows to the left of the checkmark. Once clicked, this will set Sandra testing the living daylights out of your memory. It can take a few minutes and you can't do anything else with your machine while it's running, so just let it do its thing. Of course, make sure that you're not running any other programs in the background while running this or any other benchmark.

» Once this is done, you'll be presented with a dynamic graph showing you how your memory compares to other setups (**image K**). The tabs along the top present different rankings and information—such as how your memory compares to the best value options around, as well as how you rank compared to everyone else who has run Sandra.

» Click Rank, then click the button labeled View @ SiSoftware Ranker. This will take you to a site that shows more information that can help you spot if you have a problem (**image L**). In the top section of this page, you'll find your actual memory throughput (the score), along with a "qualification" telling you whether this is a good result.

» In the Statistical Analysis section, you'll find the range that's expected from your hardware, which is a quick way to see if something isn't quite right. If your score is outside the range given, then your memory has either been configured incorrectly, or there's a hardware fault with your memory sticks or your motherboard.





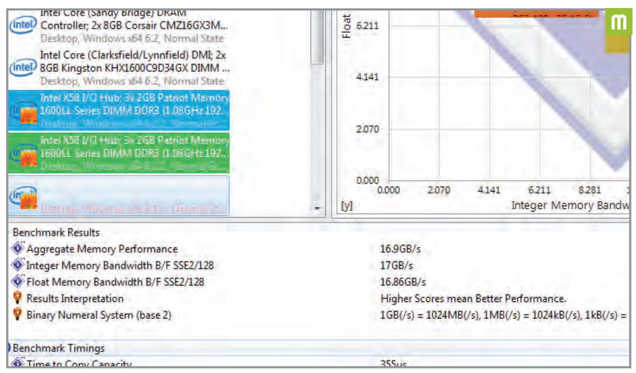


ADDRESS ANY PROBLEMS Go back to Sandra and look in the bottom box. This shows you detailed results from the benchmark you've just run, along with any specific information about how the benchmark was run—how much memory was used, for instance (**image M**). Scroll to the bottom and you'll find tips for your PC, such as whether there's a BIOS update for your PC.

» We've discovered that there's a BIOS update for our machine and that we can potentially run the RAM at faster settings than we currently do. A quick check of our motherboard manufacturer's website confirms that there is indeed a BIOS update, and after a quick download, we're rocking the latest BIOS.

» To change the memory speed, we pop into the BIOS and boost it using the Extreme Performance Profile (or XMP). How much you get out of your memory depends very much on your motherboard, but have a good look in the Performance section. The next step is to reboot and make sure we're getting the most from the memory.

» You've now seen how you can use SiSoftware Sandra to make sure you're getting the optimal performance from your memory, and you can repeat the process for other components such as the processor and graphics card. Follow the same steps, make sense of the benchmark results, and find out what the appropriate range is for your hardware.



BUILD IT

TOM MCNAMARA **ASSOCIATE EDITOR**



AMD Gaming on a Budget

This month, we build an affordable AMD-based gaming rig to find out just how good (or bad) a CPU/GPU combo can be

LENGTH OF TIME: **1–3 HOURS** | LEVEL OF DIFFICULTY: **EASY**

THE MISSION We've put together some spendy systems recently. Hey, there's a reason this mag is called *Maximum PC*. However, it's caused a few readers to wonder if we drive gold-plated Humvees to work. As if! We have chauffeurs for that kind of thing. The fact is, we like the challenge of building to a rig's optimum potential, at *any* price. So this month, we turn the tables and go full-on budget build.

The timing is perfect since AMD has just released its new "Richland" APUs (Accelerated Processing Units), and it seems like a good way to go when building a machine on change found in your couch. Plus, we hear that it overclocks well, and that the integrated graphics are pretty respectable. Thus our plan became the following: Get the best APU we could afford, good RAM, an aftermarket CPU cooler, and a solid motherboard to overclock as a baseline. Using an integrated GPU would keep the cost below $700 including Windows and an SSD, in addition to the usual items like the case, power supply, etc. Then, stuff it all into a mid-tower case with an ATX motherboard and—boom!—we have an affordable, upgradeable budget box.



GATHERING THE A-TEAM

THE INSIDE of a case looks pretty naked without at least one video card, right? For this Build It, we're running the graphics off the APU's integrated graphics processor (IGP). The APU is an AMD A10-6800K, which is a quad-core chip running at 4.1GHz, and the IGP is a Radeon HD 8670D. Since AMD's latest cards are numbered 7000 series, the IGP's numbering makes it look like it's newer or better, but it's actually a midrange chip. But the APU has a correspondingly modest price, coming in around $150 at press time. Still, it should soundly defeat the HD 4600 IGP that's in an Intel Core i5-4670, which comes in at about $230 (but whose non-IGP performance is better than the A10's in every benchmark that we've run).

This chip uses AMD's FM2 socket, instead of AM3+. We had a high-end FM2 board in the office, but with our relatively economical budget, we're going with a mid-level F2A85X-D3H from Gigabyte. We expect a solid overclock out of it despite its modest price since it offers a bevy of overclocking options. Assisting our overclock is a Cooler Master Hyper 212 Evo CPU cooler, which has the exact combination of performance and low cost that we need. We added a 60GB SSD from Mushkin as a boot drive, to give overall system performance a shot in the arm (in addition to our 1TB hard drive), and we threw it all into an NZXT Source 210 Elite. Everything gets hooked up to a Corsair CX500 power supply. The case and PSU will give us plenty of room to grow.

INGREDIENTS

	PART	PRICE
Case	NZXT Source 210 Elite	$42 (street)
PSU	Corsair CX500	$50 (street)
Mobo	Gigabyte GA-F2A85X-D3H	$85 (street)
CPU	AMD A10-6800K	$150
Cooler	Cooler Master Hyper 212 Evo	$35 (street)
GPU	Radeon HD 8670D	N/A (integrated)
RAM	2x 4GB Kingston HyperX KHX16C9B1BK2/8	$57 (street)
SSD	60GB Mushkin Chronos MKNSSDCR60GB-7	$64
HDD	1TB Seagate Barracuda	$68 (street)
Optical Drive	Samsung SH-S223	$17
OS	Windows 8 64-bit OEM	$90 (street)
Total		$658

1 BRAINS OF THE OPERATION

THE AMD A10-6800K CPU has the fastest off-the-shelf IGP available, which has made it popular for entry-level gaming systems. It beats out everything on the Intel side by a margin of about 20 percent, while costing the same or less. But it's not a conventional quad-core chip, since each pair of integer cores inside the chip share one floating-point core.

Installing the chip is easy, since the FM2 socket has pretty much the same shape as the AM3/AM3+ socket. CPU coolers for AM3+ will also be 100 percent compatible. You just pull back the lever on the ZIF socket, line up the triangles on the chip and socket, place the chip, and push the lever back down until it clicks into place.



2 THE ARSENAL

THE GIGABYTE GA-F2A85X-D3H motherboard hovers around $85, but don't let the relatively low price fool you: This is a full-featured board, with a front USB 3.0 header, eight SATA 6Gb/s ports, HDMI and dual-link DVI connectors, five PCI Express slots (of varying speeds), a backup BIOS chip, three different RAID modes, and heatsinks on the voltage regulators. Its four-phase regulation is not super-powered, but we should be able to overclock it quite nicely. It doesn't have PCI Express 3.0, but 2.0 x16 is plenty of bandwidth for a single video card if we want to add one down the line. It also supports Nvidia SLI and AMD CrossFire, though the second PCIe slot is only x4. It also accepts up to four 16GB RAM sticks, and has a total of four fan headers—one of these is right next to the CPU fan header, which makes dual-fan coolers easier to install and manage. The GA-F2A85X-UP4 is the next step up, with things like CrossFire support, six-phase power, and DisplayPort, but it's about $40 more.



3 THE MUSCLE

SINCE WE'RE NOT using a discrete video card in this system, we probably don't need more than 300 watts. But the Corsair CX500's sheer wattage and two 9-pin PCI-Express cables gives this build the option to take pretty much any single-GPU card on the market. At press time, it was also just $30 after a $20 mail-in rebate and $10 promo code on Newegg. So you get a lot of head-room for the money, and the build quality is excellent, as well, for the price. It's rated as "80 Plus Bronze," so it's respectably efficient. Its fan will adjust speeds according to temp readings, it has a unified 12-volt rail for better power distribution, and a three-year warranty.



4 THE WHEELS

THE NZXT SOURCE 210 Elite packs in a surprising amount of value for a sub-$50 case. You get a 120mm and a 140mm fan, two extra 140mm fan mounts, and two extra 120mm mounts in the front. It also has a USB 3.0 port on the front, decent cable management options, ventilation underneath the power supply mount, and a motherboard tray cut-out for easy installation and removal of the CPU cooler. The drive cage is not removable, and it faces toward the back of the case, but this design allows for good airflow and still leaves enough room for long video cards. We did make one small change; we removed the 140mm exhaust fan from the top of the case and made it an intake fan on the case door. We would have liked to move it to the front as an intake fan, but its 140mm width is too large for the dual 120mm mounts. We left the 120mm rear exhaust fan in place.



5 STORE THE SCORE

THE 1TB SEAGATE Barracuda hard drive will give us performance similar to a Western Digital Caviar Black, for less money (though the Black has a five-year warranty, instead of the Barracuda's three). We need an HDD since our SSD is really small. The Mushkin Chronos SSD did not come with a bracket or converter kit for a 3.5-inch drive bay, and this case has no 2.5-inch bays, so we grabbed a spare adapter from the Lab, but you can buy them online for about five bucks. The case's drive bays are tool-free; you just twist a knob to pull a fastener out, insert a 3.5-inch drive into the slot, put the fastener back in, and twist its knob back to the locked position.

Since the drive has no moving parts and generates negligible heat, we could normally skip the converter, save five bucks, and just tape the SSD down somewhere (behind the motherboard tray is a favorite spot of ours). Leaving the SSD in the cage makes the cabling more manageable though, and since the cage points toward the rear of the case, the orienta-tion won't obstruct airflow should an intake fan be added in the future.



6 WRAPPING UP LOOSE ENDS

THE COOLER MASTER Hyper 212 Evo CPU cooler is tall enough to actually touch the case's side panel. That's one of the trade-offs of using a cooler with such a large heatsink. It's actually the heat pipes running through the heatsink that add the extra height of about 5 millimeters. But since there isn't any electricity running through the 212 Evo or the case, physical contact between these two parts won't cause a short circuit or otherwise hurt anything. It's worth putting up with a tight fit, because the 212 Evo has a great balance of performance and price, and it's easy to install.

We could probably skip an optical drive these days, but at less than $20, it's is an acceptable insurance cost for items that only exist on an optical disc, like older versions of software, old games, music, and movies. It also allows you to install the motherboard's integrated Ethernet controller from the bundled CD, rather than having to hunt for it on the Internet.

Last but not least, we're sticking with Windows 8 from this point forward. It boots faster than Windows 7, and it doesn't require as many third-party drivers to get up and running.



1. AMD's A10-6800K has a stock speed of 4.1GHz, but we were able to push it to 4.7GHz thanks to the performance of the Hyper 212 Evo.

2. The Gigabyte GA-F2A85X-D3H motherboard packs a lot of features into its $85 street price, like a full ATX form factor and heatsinks on the voltage regulators.

3. The 60GB Mushkin Chronos SSD loaded Windows 8 in less than 10 seconds, making it easy to pop in and out of the BIOS to tweak various performance settings.

4. The NZXT Source 210 Elite is surprisingly sturdy and adaptable for the price, and allows up to seven 120mm fans. The Corsair 200R is an alternative option for budget-oriented gamers.



A PLAN COMES TOGETHER

ONCE WE WERE UP and running, one of the first things we wanted to do was overclock, to see how much it would compensate for the lack of a dedicated video card. We increased the CPU clock by 600MHz ,to 4.7GHz; and the APU's Radeon 8670D has a separate clock speed setting in the BIOS, which we increased by 50MHz, to 894MHz.

The end result soundly defeated Intel integrated graphics. For example, the HD 4600 IGP in the Intel Core i7-4770K managed about 45fps in Portal 2 at 1080p with all effects on (minus antialiasing), when we tested it at launch. In this build, the HD 8670D got about the same frame rate—but we were able to run 4x multisample antialiasing, as well.

We also tested Amnesia: The Dark Descent, which uses fancy visual effects like ambient occlusion (AO) and parallax mapping. Here, the chip barely managed to run at 30fps at 1080p, though that was at the "high" preset. Disabling AO gave back 10–15fps. Borderlands 2 ran at 25–30fps at 1080p on the lowest settings. (If you're looking for better gaming performance on a budget, a Phenom II 965 and Radeon HD 7770 can have the same total cost as a 6800K that uses an aftermarket CPU cooler, if you shop around and don't mind mail-in rebates.)

The non-GPU performance was also pretty good for the money. In CPU tests it outshone the AMD Phenom II X4 965 in our budget zero-point system—and sometimes demolished it. AMD's latest CPU cores are a lot better at encoding video in ProShow, where it slashed a whopping 20 minutes off the encode (though the 4.7GHz clock speed also helps). If you're solely looking for CPU performance, however, AMD's FX 6300 would be a better choice due to its superior CPU chops.

The bottom line is that the AMD 6800K has the fastest integrated graphics you can buy off-the-shelf. Intel's "Iris Pro" silicon that's embedded in some of its new Haswell CPUs appears to be faster based on the numbers we've seen, but the CPUs it's paired with are not available outside of pre-built systems, and they're pretty expensive. So if you're an infrequent gamer with a modest budget, the 6800K is a great piece of hardware.

Otherwise, the Mushkin SSD booted and loaded apps very quickly, though a larger one would have been helpful; the 60GB model fit Windows and a few games, and that's about it. Overall, we are satisfied with the performance and build quality of the system, even though our inner performance junky craves a video card and liquid cooling.

BENCHMARKS

	ZERO POINT	
Stitch.Efx 2.0 (sec)	1,813	1,710
ProShow Producer 5.0 (sec)	3,127	1,947
x264 HD 5.0 (fps)	8.0	9.0
Stalker: Call of Pripyat (fps)	29.9	8.3 (-72%)
3DMark11 Performance	3983	1668 (-58%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point is a Phenom II X4 965 BE, Gigabyte GA-970A-UD3, 4GB of DDR3/1333, Asus Radeon HD 7770, Samsung 840, and WD Caviar Blue 1TB HDD. All tests were run on Windows 8.

REVIEWS

TESTED. REVIEWED. VERDICTIZED.



INSIDE

PRIMORDIAL MEDUSA X79 PAGE 70



This big rig features an odd storage subsystem configuration.

Primordial Medusa X79

Can this four-way Titan box dethrone Dream Machine?

WITH DREAM MACHINE 2013 behind us (September 2013), we now move into the phase where vendors line up to try to kick it off the top of the heap.

With the Medusa X79, Primordial certainly tries its damnedest. Some will peep the jet-black Corsair 900D, four-way Titan SLI, and Asus Rampage IV Extreme motherboard and think Primordial tried to clone the Dream Machine's internals.

We can assure you that it's not true. In fact, we know Medusa X79 was already making the media rounds at the time that Dream Machine was still being assembled. What's more, there are some huge differences between the two.

The Dream Machine used Intel's Core i7-3970X clocked up to 5GHz, while Primordial chose the economical Core i7-3930K chip overclocked to 4.5GHz. DM's GPUs were off-the-shelf jobbies from EVGA, while the Titans in the Medusa X79 have been retrofitted with Heatkiller parts.

There's also a big difference in storage subsystems and main memory—choices we're not sure we agree with. For RAM, Primordial went with 16GB of Corsair Platinum DDR3/1866. Call us crazy, but in this class of machine, we'd expect more RAM, even if the vast majority of folks don't actually need it. We're also not down with the storage options. The Medusa X79 features two 120GB Intel 520 SSDs in RAID 0 and a 1TB Western Digital Caviar Black drive. Again, we think that's an odd choice given this machine's caliber—and price. We've seen this type of storage config a couple of times now, with the CyberPower PC in our September issue and the Geekbox machine in February. We rarely ding vendors severely for such choices, as it's something the typical enthusiast changes at order—but come on, vendors, that hard drive shortage of ought-11 is way over.

The real question is whether the Medusa X79 successfully dethrones the Dream Machine. The short answer is no. With its CPU hanging back at 4.5GHz, the Medusa X79 fell short of the Dream Machine by about 10 percent in every CPU-related test. In gaming, we saw things a bit closer. In Batman: Arkham City the two boxes were dead even, but with the more intense 3DMark 11, Dream Machine had the edge by a hefty 7 percent margin. But let's not kid ourselves: The Medusa X79 is not a slow machine. We can tell you that with four Titan cards, its fully capable of 4K-resolution gaming. It easily slaughters our zero-point system, too.

One area where Medusa had the Dream Machine dead to rights was in power consumption. While we could barely scrape up enough amps to run DM2013 without crashing neighboring machines in corporate accounting, the Medusa X79 practically sips power. Well, by sip, we mean 1,300 watts on heavy loads—DM2013 pushed 1,600 watts.

The real problem for some will be the Medusa X79's price. While it's actually quite a bit "cheaper" than the Dream Machine's $12,785 (sans 4K monitor), it's still pushing $9,500. More than half of the price is easily tied up in the custom-cooled Titan setup and other sundry custom liquid components, but it just feels as though the box is imbalanced. In this day and age, balance doesn't just mean getting the GPU and CPU right and calling it quits; there are other parts too, such as storage. That inequity combined with the relatively "low" overclock of 4.5GHz, means Dream Machine is safe for now. –**GORDON MAH UNG**

VERDICT 8

Primordial Medusa X79

+ BEEHIVE Four-way SLI; fairly quiet.

– BOUFFANT Pricey; limited storage capability.

$9,556, www.primordialcomputers.com

BENCHMARKS

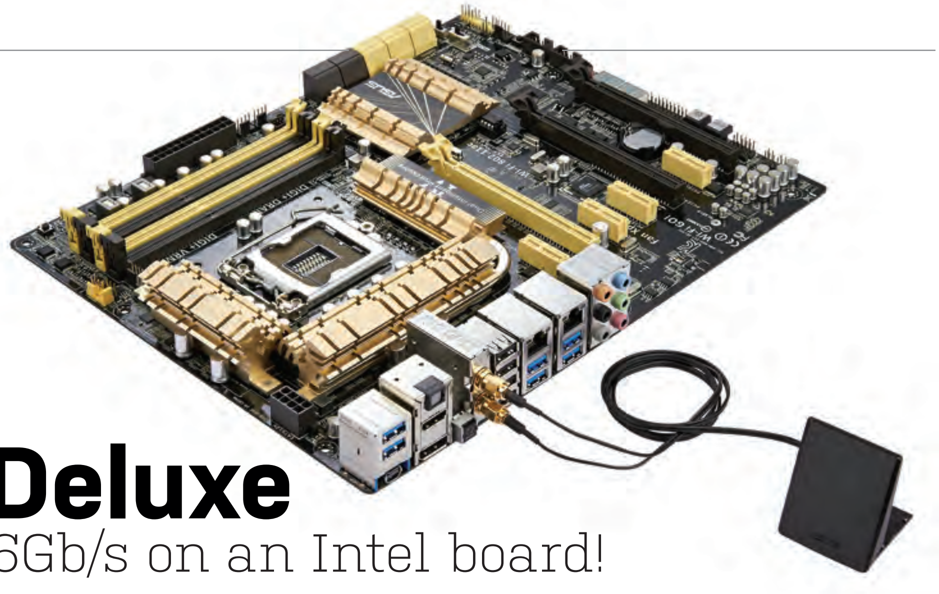
	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	1,721
Stitch.Efx 2.0 (sec)	831	733
ProShow Producer 5.0 (sec)	1,446	1,281
x264 HD 5.0 (fps)	21.1	24.4
Batman: Arkam City (fps)	76	179 (136%)
3DMark 11	5,847	16,136 (176%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our current desktop test bed consists of a hexa-core 3.2GHz Core i7-3930K 3.8GHz, 8GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

SPECIFICATIONS

Processor	Intel Core i7-3630K @4.5GHz
Mobo	Asus Rampage IV
RAM	16GB Corsair DDR3/1866
Video Cards	4x EVGA Titans in SLI, with Heatkiller water blocks and backplates
Sound Card	Onboard
Storage	2x 120GB Intel 520 SSD in RAID 0, 1TB WD Caviar Black 7,200rpm
Optical	LG Blu-ray drive
Case/PSU	Corsair 900D, EVGA SuperNOVA 1,500 PSU



With the exception of Goldmember, PC users may miss the old blue heatsinks.

Asus Z87-Deluxe

Finally, all SATA 6Gb/s on an Intel board!

MOTHERBOARD shopping used to be like buying a Model T—you could buy any color you wanted as long it was black. Today, we have a serious Nerd World problem in the dizzying array of motherboard choices, with Asus offering no less than 10 Z87 boards just in its "standard" line, at prices that range from ultra-budget to luxury.

The Z87 Deluxe comes in near the top of Asus's consumer line, and immediately raises the question, "Is it worth it?" given its price tag of about $290 on the street. That's hard to say, but Asus has ladled on enough features to make a convincing argument.

There's 802.11ac with a redesigned antenna, Bluetooth 4.0 for support of ultra-low-power devices such as the Fitbit, and multi-GPU support for up to two Nvidia cards in SLI or up to three AMD cards in CrossFireX. The wireless support may seem extraneous on a desktop board, but Asus has a few tricks to get you to use it. You can, for example, set the 802.11ac to access-point mode and use it to sync files with your phone. Another mode allows you to use your phone as a remote desktop session. Sounds nifty, but we couldn't figure out how to zoom in on the Android app, making it useless. It would also be nice if there was a way to know that the mode is on, lest someone remotely control or—watch—our screen without our knowledge.

Elsewhere in the board, Asus does a polish job on its already excellent UEFI implementation. For a long time, Asus's UEFI has been our pick of the litter and only recently have competitors come close. New features include a notebook, favorites, and—the most handy—a list of what you just changed in the UEFI as you exit. Asus's other strong suite has been its AI Suite software, which also leads the pack in usability. It too has been polished up.

Other extras include dual NICs, with one using an Intel PHY, and the latest Realtek audio codec, the ALC1150. We put on a set of analog gaming cans and did some close listening to lossless audio while hammering the USB 3.0 ports with data and couldn't discern any of the electrical noise that can crop up with onboard audio.

Moving to performance, we configured an Intel DZ87KLT-75K with the exact same components and then quickly watched the Z87-Deluxe mercilessly smack the Intel board around. Magic? Well, yes, if the magic is running the Core i7-4770K at higher boost clo cks. The Z87-Deluxe consistently ran the Haswell at 4.2- or 4.3GHz when the Intel board would nary go past 3.9GHz on Turbo Boost. That let the Asus board run away with most of the benchmarks. There was even a little overclocking room left. Using the board's auto-overclock, it set a clock speed of 4.6GHz. That's pretty audacious for a Haswell chip. The only place where the Intel board came out ahead was in storage, where it edged out the Z87-Deluxe in I/O across the native Intel SATA ports as well as the USB 3.0. Overall, though, we give the "performance" nod to the Asus board because it pushes the chip far harder than Intel does with its own motherboard.

So, is it worth it? Yes and no. We'll be honest. Not everyone needs the fancy Wi-Fi/ Bluetooth features nor 10 SATA 6Gb/s ports. But then again, do you *really* need the leather seats in your car? Or the heated mirrors and HID lamps? No, but that doesn't make it bad to have them, either. It's just a question of whether you want to be pampered or to drive around in a strippo. –GORDON MAH UNG

BENCHMARKS

	Asus Z87-Deluxe	Intel DZ87KLT-75K
3DMark Firestrike Score	**8,694**	8,563
3DMark Graphics	9,715	**9,736**
3DMark Physics	**11,676**	10,137
PCMark 8 Home Score	**5,824**	5,146
PCMark 8 Creative Score	**5,925**	5,340
PCMark 8 Work	**5,562**	4,947
Sandra Memory Bandwidth (GB/s)	24.07	24
CrystalDiskMark Seq. R/W SATA (MB/s)	531.1 / 507.1	**541 / 520**
CrystalDiskMark Seq. R/W USB 3.0 (MB/s)	428.7 / **371.7**	**432.8** / 348.9
Valve Particle (fps)	**211**	196
Hitman Absolution low-res (fps)	**82.3**	71.9

We used a Core i7-4770K, 8GB of DDR3/1866, Cooler Master 212 Evo, Corsair 240GB Neutron GTX , GeForce GTX 780, and Windows 8 for our testing. Crystal disk mark scores used a 250GB Samsung 840 Pro on SATA 6Gbps and in an Asmedia enclosure on USB 3.0.

VERDICT 9

Asus Z87-Deluxe

➕ **MCLEAN** Aggressively works the Haswell chip; bundled 802.11ac.

➖ **MCDLT** A bit pricey; we miss the blue.

$290, www.asus.com



The 14-inch version of the Razer Blade is thinner than a dime—standing on its side.

Razer Blade

Good gaming notebook, small package

WITH BOTH Intel's Haswell and Nvidia's new 700M-series components shrinking in size and sipping less power, the super-portable, 14-inch gaming laptop revolution is about to begin. Leading the charge is Razer, with its new, ultra-sleek Razer Blade gaming notebook—a smaller take on the 17-inch version (since rebranded as Razer Blade Pro) we reviewed in our Holiday 2012 issue.

Like its larger predecessor, the Blade features the same alluring green LED-backlit keyboard and matte-black aluminum chassis, although its predecessor's LCD trackpad has been replaced by a more traditional trackpad centered under the keyboard.

Arguably, the biggest selling point of the new Blade, however, is that it's ridiculously svelte, with its chassis measuring 13.6x9.3x.66 inches. Razer claims it's the world's thinnest gaming laptop and it's certainly the slimmest we've tested. With the lid closed, the laptop is thinner than a standing dime. It's light, too, weighing four pounds, 3.3 ounces. It's clearly one highly portable device, though some inputs were sacrificed in achieving that distinction; it has just three USB 3.0 ports, an HDMI port, and an analog 1/8-inch audio jack.

We're also not crazy about its matte TN panel—we'd have preferred the better viewing angles and more accurate color reproduction of an IPS monitor. We'd also have preferred a 1080p resolution as opposed to the Blade's 1600x900. We have no complaints about the speakers, however, which were crisp and surprisingly loud for such a small laptop.

The Razer's trackpad is highly responsive, supports multi-touch gestures, and has dedicated left and right buttons (rather than integrated into the trackpad)—something you don't see a lot of these days. But the buttons on both it and the keyboard feel a little fragile, like they could pop off after a few thousand clicks.

Beneath the keyboard, the Razer Blade is equipped with a quad-core Haswell Core i7-4702HQ, a GeForce GTX 765M, and 8GB of DDR3. Disappointingly, the Blade's only means of storage is a 256GB mSATA SSD, but one can opt for the 512GB SSD configuration for an additional $300. With game installs eating up 25GB and more these days, that 256GB will go pretty quickly.

Regardless, the Razer Blade was able to manhandle our much bulkier MSI GT60 zero-point in the benchmarks. The gains weren't massive in our CPU tests, with the Blade stalemating our ZP's 2.3GHz Ivy Bridge part in ProShow and only besting it by single-digit percentages in Stitch.Efx and x264, but it's worth noting that the Blade's Haswell part is a thriftier 37-watt CPU compared to our ZP's 45-watt TDP. The real advantage showed itself in our battery test, where the Blade lasted nearly 30 percent longer.

Graphics-wise, Nvidia's 765M GPU allowed the laptop to really hit its stride, performing at least 30 percent better in 3DMark 11 and running 60 percent faster in STALKER: CoP. In our experiential tests, we were able to play the graphically demanding Far Cry 3 on high settings with average frame rates in the mid-40s, which is ridiculously good for such a small device. The laptop was also quick to boot, launching to Windows in under 14 seconds.

The Razer Blade isn't without its flaws, but the fact that it's half the size of many gaming laptops while offering much more power, all in a super-sexy form factor, is crazy. It may not be cheap at $2,000, but Razer's ability to squeeze in the most power per cubic-inch is noble and worthy of accolades. **–JIMMY THANG**

VERDICT 9

Razer Blade

+ SHARP Sexy, super-thin, and super-portable; fantastic performance for its size.

– DULL TN monitor; chintzy-feeling keyboard/trackpad buttons; no HDD.

$2,000, www.razerzone.com

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	1,092	1,053
ProShow Producer 5 (sec)	1,786	1,797 (-0.6%)
x264 HD 5.0	12.0	12.7
STALKER: CoP (fps)	32.8	53.4
3DMark 11 Perf	2,979	4,017
Battery Life (min)	187.0	239

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point notebook is an MSI GT60 with a 2.3GHz IntelCorei7-3610QM, 12GB DDR3/1600, two 500GB Seagate 7,200rpm hard drives, a GeForce GTX 670M, and Windows 8 64-bit.STALKER: CoP tested at 1920x1080 with Ultra settings, Tessellation, and contact hardening.

SPECIFICATIONS

CPU	2.2GHz Intel Core i7-4702HQ
RAM	8GB DDR3/1600
Chipset	Intel HM87
GPU	Nvidia GTX 765M
Display	14-inch, 1600x900 TN (matte)
Storage	256GB mSATA SSD
Optical Drive	Not included
Connectivity	HDMI, 3x USB 3.0, audio in, 1.3MP webcam, built-in Bluetooth, Killer Wireless-N 1202
Lap / Carry	4 lbs, 3.3 oz / 5 lbs, 2.7 oz



EVGA's GTX 780 sports a slick new cooler design that covers the entire 10.5-inch card and only takes up two slots, making it perfect for SLI.

EVGA GTX 780 SC w/ACX

As good as it gets

THIS MONTH, EVGA is unveiling its GeForce GTX 780 as well as an all-new GPU cooling design dubbed ACX, which it plans to stick on all its high-end GPUs for the foreseeable future. The cooler's acronym stands for Active Cooling Extreme since it uses active cooling and it's more extreme than getting a Red Bull enema.

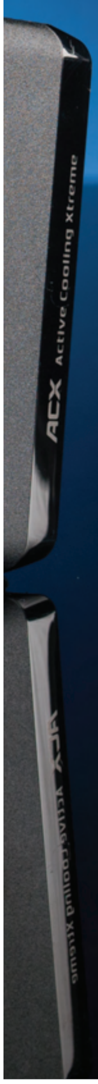
Honestly, it's high time EVGA came out with this, as it's been using a slightly modified version of the Nvidia reference "blower" design for way too long, so it'll now be able to compete with Asus's DirectCU II, MSI's Twin Frozr, and Gigabyte's Windforce designs. EVGA says the new cooler offers a 40 percent increase in heatsink volume, which translates to 15 percent lower temps and totally silent operation. The biggest thing it's promoting is that the fans use ball bearings instead of the sleeved variety, allowing for longer life and quieter operation. The new heatsink covers the entire card—all 10.5 inches of it—so the VRMs and RAM are also covered by the cooling apparatus. EVGA offers six variants of this particular card, and this is its flagship air-cooled model, the SuperClocked ACX board.

Compared to the stock design, which has a Titan cooler by the way, this silver siren features a 104MHz overclock to the base clock, 118MHz overclock to the boost clock, and the aforementioned extreme cooler. It retains the stock card's 3GB of memory and 6GHz memory clock. That huge-ass fancy cooler only adds $10 to the price of the stock card, which is surprising. Sure, we're used to seeing aftermarket coolers go for $10 or $20 more over stock, but this cooler looks so premium we expected it to be more expensive, especially since the card is also overclocked. We should point out that the card's hardware "bundle" is, well, crappy and small, but we are coming to terms with the state of video card bundles now—which is to say they're all like this.

In testing, we saw the ACX-cooled GTX 780 run neck-and-neck with the more-expensive GTX Titan, effectively closing the gap between the two cards in a way that just isn't possible on the GTX 780 reference board, at least not in our testing. This is the first card we've seen get this close to a Titan, and in the tests where it didn't match it, the ACX card came within spitting distance, which is damned impressive. It was able to match the Titan in Heaven 4.0, Far Cry 3, Tomb Raider, and Battlefield 3.

More good news: We were able to overclock the ACX board a fair bit, using the superb EVGA PrecisionX software, eventually getting it up to 1,149MHz boost by nudging the power-target slider to 106 percent and tweaking the xGPU offset to +59MHz. Under full load, overclocked, the ACX cooler kept the card at a steady 75 C, which is about 10 C cooler than stock.

Let's recap then: sexy good looks and blistering benchmarks, cool and quiet performance, overclockable, as fast as a Titan, the best overclocking software around, and only $10 more than a stock board. Sounds like what is basically a perfect video card to us. –**JOSH NOREM**



BENCHMARKS

	EVGA GTX 780 SC w/ACX	GTX 780 (Reference)	GTX Titan	PowerColor AMD Radeon HD 7970 GHz
Driver	320.49	320.18	320.49	13.5 Beta 2
3DMark Fire Strike	9,607	8,482	**9,892**	7,138
Unigine Heaven 4.0 (fps)	**40**	35	**40**	24
Crysis 3 (fps)	27	24	**32**	24
Shogun 2 (fps)	55	48	**63**	43
Far Cry 3 (fps)	**42**	35	**42**	30
Tomb Raider (fps)	**25**	**25**	**25**	20
Metro: Last Light (fps)	24	22	**25**	14
Battlefield 3 (fps)	**55**	53	**55**	41
Catzilla Beta	7,660	6,933	**7,926**	4,889

Best scores are bolded. Our test bed is a 3.33GHz Core i7-3960X Extreme Edition in an Asus P9X79 motherboard with 16GB of DDR3/1600 and a Thermaltake ToughPower 1,050W PSU. The OS is 64-bit Windows 7 Ultimate. All tests, except for the 3DMark tests, are run at 2560x1600 with 4X AA.

VERDICT 10 KICK ASS!

EVGA GeForce GTX 780 SC w/ACX

+ **AFTERMARKET** Everything.
- **STOCK** Nothing.

$660, www.evga.com

The 840 Evo replaces the company's vanilla 840 drive, but actually threatens the Pro drive.



Samsung 840 Evo 1TB

Fastest. SSD. Ever.

THE SAMSUNG 840 Pro landed on our Best of the Best list when it was launched in December 2012, and it has remained at the top of the SSD pile ever since, thanks to its blistering speed, impeccable pedigree, and superb software. Shortly after the Pro launched, Samsung debuted a non-Pro drive, named simply "840," that was designed for those who wanted a less expensive drive with a smaller three-year warranty. This month, Samsung is replacing the regular 840 with the 840 Evo, an all-new drive that slots in below the 840 Pro, thanks to its three-year warranty (the Pro's is five years) and more reasonable pricing. The Evo is also offered in a full range of capacities, from 120GB all the way up to 1TB, making it the first Samsung SSD available at that size and putting the 1TB Crucial M500 directly in its sights, although the Evo does cost $50 more at $650 MSRP.

To create the Evo, Samsung added new 19nm MLC NAND, a new controller named MEX (its previous one was called MDX), and new caching technology it calls TurboWrite. This caching method treats a portion of the drive's MLC NAND as if it were far pricier and faster SLC NAND for buffered writes, allowing for a significant boost in speeds when utilized. The amount of NAND reserved for this varies according to the drive's size; on the 1TB review drive we have it's 36GB, which becomes a 12GB "SLC" buffer—3-bit MLC converted to 1-bit SLC NAND.

In addition to the TurboWrite thing, Samsung has also added a Rapid Mode, enabled in the Samsung Magician software, that uses the host system's DRAM and CPU for caching purposes. It caches frequently used files in system memory and can dramatically increase read and write speeds. Rapid Mode can be switched on and off in the software, and requires just 50MB of RAM and an 840 Evo SSD to be activated. Samsung says it will eventually bring the caching technology to its 840 Pro drive, but for now it's exclusive to the Evo.

To test the Evo drive, we attached it to our SSD test bench, installed version 4.2 of the Samsung Magician software, initiated the AS SSD incompressible data benchmark, and went to get a cup of coffee. When we returned, we were lucky not to have been sipping coffee when we saw the numbers because we surely would have done a spit-take. The Evo racked up a score of 855MB/s for reads and 1GB/s for writes, and over 100K IOPS in 4K random writes, as well. As we progressed through our test suite, the Evo laid waste to all the previous drives and became the fastest SSD we have ever tested by a sizable margin, even beating out its big brother, the more expensive 840 Pro. We also tested the drive with Rapid Mode disabled, and it was still extremely fast, making it a supremely competitive SSD that seems to have no weaknesses other than its short three-year warranty. –JOSH NOREM

BENCHMARKS

	Samsung 840 Evo (Rapid Mode)	Samsung 840 Evo (Normal Mode)	Crucial M500	Samsung 840 Pro	Corsair Neutron GTX
Controller	MEX	MEX	Marvell 88SS9187	MDX	LAMD
Capacity	1TB	1TB	480GB	512GB	480GB
CrystalDiskMark					
Avg. Sustained Read (MB/s)	**594**	519	480	534	441
Avg. Sustained Write (MB/s)	**591**	500	422	514	478
AS SSD - Compressed Data					
Avg. Sustained Read (MB/s)	**855**	506	493	513	507
Avg. Sustained Write (MB/s)	**1,002**	496	408	495	475
ATTO					
64KB File Read (MB/s)	519	494	502	**524**	345
64KB File Write (MB/s, 4QD)	**659**	510	422	497	485
Iometer					
4KB Random Write 32QD (IOPS)	88,859	**89,423**	83,354	82,927	85,375
PCMark Vantage x64	**100,797**	57,306	71,619	75,205	67,426
Sony Vegas Pro 9 Write (sec)	**272**	277	485	294	286

Best scores are bolded. All tests conducted on our hard drive test bench, which consists of a Gigabyte Z77X-UP4 motherboard, Intel Core i5-3470 3.2GHz CPU, 8GB of RAM, Intel 520 Series SSD, and a Cooler Master 450W power supply.

VERDICT 9 KICK ASS!

Samsung 840 Evo 1TB

ROYAL NAVY Ridiculously fast; effective caching; every capacity.

ROYAL BABY Only three-year warranty.

$650, www.samsung.com



Despite its front fan having a depth of 25mm, the C5 won't get in the way of RAM slots.

Thermaltake NiC C5

Give a little, take a little

WE DON'T KNOW how it started, but heat spreaders on today's RAM sticks have gotten kinda out of control. So, gearheads these days have to get pretty creative (or potentially destructive) to fit most large aftermarket CPU coolers on the motherboard. Thermaltake had the bright idea to just make a more compact cooler, with not one but two 120mm fans on it. NiC stands for "Non-Interference Cooling," and its C5 model sits at the top of the vendor's lineup. With five heat pipes and 230 watts of heat dissipation, it's ready for serious cooling, and it won't get in the way of your RAM slots.

Now, Thermaltake had to make an adjustment to accommodate fancy RAM sticks. It reduced the thickness of the heatsink by about 10mm below average at its narrowest point. The heatsink of the popular Cooler Master Hyper 212 Evo, for example, ends up about a quarter-inch thicker. In other design tweaks, Thermaltake also went with a 3-pin fan connector; you adjust the fan speed with a knob on the cable itself, rather than through the BIOS or Windows-based software. Since the C5 runs relatively quiet and cool around 1,200rpm, it's not actually something you need to fiddle with very much.

On paper, the C5's dual fans should overcome the reduced surface area of its heatsink. And for the most part, they do. But we did have an issue with the sheer noise level. It was difficult to pinpoint the source; sometimes the fan-blade design introduces a lot of turbulence, and the shroud around the cooler leaves a small gap between the fans and the heatsink. The C5's fans ramp up in 200rpm increments, starting at 1,000rpm and becoming noticeably louder with each increase. We set the fans to 1,400rpm to keep the C5 on a level playing field with the 212 Evo, which leveled off at that speed when set to "quiet mode" during our thermal tests. The C5's noise was less than tolerable, and the cooling was about the same as the Evo, which costs about half as much.

Sound is a subjective thing in the end, but we can think of several entry-level closed-loop liquid coolers that provide similar cooling at lower noise levels, so it's difficult to visualize a niche for the C5. The Corsair H60 or even Thermaltake's own Water 2.0 Performer would be a better choice for the money. Granted, the C5 won't leak fluids inside your PC anytime soon, and it won't occupy a case fan mount.

You could simply replace the fans with something quieter, but since Thermaltake is already asking $55 for the C5, good 120mm fans push the price tag into the area of much stronger performers, such as the Phanteks TC14PE or even a Corsair H80i.

Installation is pretty straightforward, with a universal metal backplate and a conventional set of screws and brackets. No black magic required. You could even connect the fans directly to the power supply, since they're controlled with the knob. But the high noise level keeps the C5 out of serious contention. At press time, its North American availability was also pretty low, despite being announced in March—the only store selling it was Xoxide.com. –**TOM MCNAMARA**

VERDICT 7

Thermaltake NiC C5

+ POCKET ROCKET Great RAM clearance; easy installation.

− HOT POCKETY A bit noisy; 3-pin fan; underwhelming price.

$55, www.thermaltakeusa.com

BENCHMARKS

	NiC C5 Quiet / Performance Mode	212 Evo Quiet / Performance Mode	Phanteks TC14PE Quiet / Performance Mode
Ambient Air	21.3 / 21.5	20.5 / 20.0	20.0 / 19.9
Idle Temperature	33.0 / 30.3	35.5 / 30.5	**32.0 / 28.5**
Load Temperature	71.8 / 68.2	**70.0 / 67.3**	70.3 / 68.6
Load - Ambient	50.5 / **46.7**	**49.5** / 47.3	50.3 / 48.7

All temperatures in degrees Celsius. Best scores bolded. All tests performed with an Intel Core i7-3960X at 4.1GHz, on an Asus Rampage IV Extreme motherboard, in a Corsair 900D with stock fans set to Standard.

SPECIFICATIONS

Heatsink Dimensions (H x D x W)	6.3 x 1.97 x 5.51 inches
Weight	1.8 lbs
Stock Fans	2x 12cm 3-pin
Socket Support	LGA1150/1155/1156/1366/2011; AM2/ AM2+/AM3/AM3+/FM1/ FM2
Additional Fan Support	None



The Lightning is the highest-clocked GTX 770 available.

MSI GeForce GTX N770 Lightning

A bit too extreme, as it turns out

LAST MONTH, we reviewed two GeForce GTX 770 cards from Asus and Gigabyte that cost just $10 more than the reference design, but were well-cooled and only slightly overclocked. That's too boring for MSI, which decided to take its flagship GeForce GTX N770 Lightning to an extreme not previously seen.

This bad mutha costs $50 more than a stock card, and with its massive cooler, is designed for hardcore overclocking straight out of the box. This ain't no 20MHz overclock neither, but 104MHz on the base clock, and 117MHz on the Boost clock. You could theoretically take it even further, given the card's prodigious cooler, but in testing we were unable to push it much beyond its highly overclocked stock settings. We also experienced some stability issues, leading us to wonder if this extreme card was pushed a bit too hard at the factory for general consumption.

As a flagship GPU, you'd expect this card to be ballin' and it is that. Not only does it use a Twin Frozr cooler larger than the land mass of Asia, but it's also built with "military class" components throughout, and includes hardcore extras such as three headers for taking voltage measurements along with the appropriate cables, an extra-long SLI cable in case you want dual Lightnings, and an absolutely massive heatsink/fan assembly. Additionally, the back of the card features an extra PCB directly underneath the GPU core dubbed GPU Reactor, which helps provide additional power filtering. It's removable for situations where it won't clear a CPU cooler, but we left it on for testing as we had the room for it. When the card has power, it glows blue and is a great ice-breaker at LAN parties. The card also features a dual-BIOS switch with both normal BIOS and an LN2 BIOS for serious overclocking. Suffice to say, this is a premium card designed for crazy overclocks even beyond the default overclocked state.

As expected, the card was indeed the fastest GTX 770 we've tested thus far, but not by as large a margin as one would expect given its price point. This card costs $40 more than the Asus and Gigabyte boards we tested last month, and the extra money is not justified, at least not for regular desktop users.

An even bigger issue is that both cards we received for testing were not stable. The first card committed GPU suicide; the second card would hard lock the system running Heaven 4.0 at stock clocks. We tried underclocking 100MHz and saw improved stability, but that shouldn't be necessary. Finally, just to make sure it was the card and not our test bench, we ran a stock GTX 770 card *overclocked* in the same test bench and had zero issues. We also ran the afflicted N770 on a second test bench, and it froze that system, too. MSI told us it had never seen a card with these issues, but our experience indicates that buyers should proceed with caution. –JOSH NOREM

BENCHMARKS

	MSI GTX N770 Lightning	Asus GeForce GTX 770 DirectCU II OC	Gigabyte GTX 770 WindForce	GTX 770 (Reference)	XFX Radeon HD 7950
3DMark Fire Strike	**7,674**	6,988	7,290	6,932	6,099
Catzilla (Tiger) Beta	**6,019**	5,992	5,978	5,604	4,024
Unigine Heaven 4.0 (fps)	25	25	**26**	24	20
Crysis 3 (fps)	**25**	**25**	21	17	17
Shogun 2 (fps)	**48**	41	43	39	34
Far Cry 3 (fps)	32	32	**33**	30	27
Metro: Last Light (fps)	**19**	**19**	**19**	17	12
Tomb Raider (fps)	19	20	**21**	20	18
Battlefield 3 (fps)	**40**	**40**	**40**	38	35
Core/Memory Clock (MHz)	1,150/7,000	1,058/7,000	1,137/7,000	1,046/6,000	860/5,000
Rated TDP	260W	230W	230W	230W	200W

Best scores are bolded. Our test bed is a 3.33GHz Core i7-3960X Extreme Edition in an Asus P9X79 motherboard with 16GB of DDR3/1600 and a Thermaltake ToughPower 1,050W PSU. The OS is 64-bit Windows 7 Ultimate. All tests, except for the 3DMark tests, are run at 2560x1600 with 4X AA.

VERDICT 6

MSI GeForce GTX N770 Lightning

+ **LIGHTNING** Fastest GTX 770 you can buy; quiet and cool; premium package.

– **THUNDER** Too expensive; stability issues.

$450, http://us.msi.com



A hidden fan controller hub can service up to 10 fans.

NZXT Phantom 530

A few more inches on the inside would make it Kick Ass

NZXT'S FULL-TOWER Phantom 530 case reminds us of the title character in *Beverly Hills Ninja*. The case tries hard to be sleek, quiet, and perfect, but just a few tiny missteps (or a mountain of them, if you're Chris Farley) keep this chassis from attaining killer black-belt status.

For example, it's a bit odd to find the case's reset switch behind the sturdy front panel. We're not sure why NZXT couldn't just split the real estate used by the case's larger power switch up top, for the sake of convenience. The case's two USB 3.0 ports are much more ideally located on the case's front-top, as is the case's built-in, three-speed fan controller and internal LED-light toggle—a lovely touch that NZXT has brought along from other cases in its Phantom line.

The case's three 5.25-inch bays can be easily accessed via the case's front, snap-lock covers, and they use their own simple locking mechanisms to keep your parts in place sans screws (though you can still double-secure your parts with screws from the case's right side). Three removable sets of drive bays, holding six drives total, sit below. We appreciate just how easy it is to remove unused drive bays as much as we enjoy the bays' drive trays themselves—installing and removing hard drives is a five-minute task, if that.

While the Phantom 530 offers a large cut-out area on its motherboard tray for easy access to aftermarket coolers, the case's shorter depth means that your standard ATX motherboard is going to run right up against the case's four big rubberized cable-routing holes. Depending on where you slot your video card(s), they're going to cover up a few of these. And you definitely won't have room to add a supplemental 12cm or 14cm pivot fan that's attachable to the left side of the case's drive bays. Were the case just a little bit bigger, all these tweaks would work much more harmoniously.

There's plenty of room on the case's ceiling to add a 12cm or 14cm radiator setup or, if liquid isn't your thing, fans ranging from 12cm to 20cm in size. We like the case's diversity as much as we appreciate its silence. With its default 14cm rear fan and 20cm front fan spinning away, you can barely hear anything, even after you set the Phantom 530's fan controller to full-blast. The case also allows you to slot in extra fans on the bottom and on its side panel, if you want to create a miniature hurricane underneath your desk.

Our one sticking point? The grill that covers the case's side panel fan mount doesn't run a tight enough weave, which gives you a pretty clear view directly into the fan itself or, if you're running bare, two of the case's drive bays. The misstep detracts from the case's aesthetically pleasing side window and is one that could have been corrected quite easily.

All in all, we appreciate a number of the Phantom 530's design elements. A few extra tweaks—and maybe a wee bit more space on the inside—could really help this chassis land the killing blow against the rest of its full-tower competition. We might not use it to house our most elite of systems, but it's otherwise good enough—and inexpensive enough—to offer a compelling building experience.
–DAVID MURPHY

VERDICT **9**

NZXT Phantom 530

➕ **NINJA WARRIOR** Built-in fan controller; super quiet; mostly tool-free; lovely LED/side-panel window combination.

➖ **NINJA TURTLE RAP** A bit small; poorly placed, ugly grilled mesh on side window.

$130, www.nzxt.com

Lenovo ThinkPad Helix

Jack of all trades, master of none

WHAT DO YOU CALL a device that can be either a laptop or a tablet, or even a few additional novel form factors in between? A Lenovo ThinkPad Helix, that's what—which, as the name implies, is a hybrid with a twist.

Here's how it works: In laptop form, the screen is firmly affixed to a keyboard dock, forming your standard clamshell. But press a button on the dock, right below the lower-left corner of the screen, pull up on the screen, and—voilà—the screen is freed to serve as a stand-alone tablet. Or you can flip the screen around, return it to the dock facing backward, and either put the device into presentation mode (hinge on top, keyboard dock acting as a kickstand), or fold the screen flat so it's facing outward while covering the keys. Both instances provide a quasi-tablet experience while retaining the extra dock's bigger battery.

That's a lot of versatility, for sure. Yet for all its possible permutations, the Helix comes up lacking.

It's most glaring weaknesses are as a laptop. At the top of the list is the fact that you're getting an Ivy Bridge processor—namely, a 1.8GHz Core i5-3427U—where the greater power savings of a Haswell proc would make more sense. But even that wouldn't remedy our other gripes. At 11.16 inches, the Helix is small, but on a whole it's not especially thin or light. It measures .8 inches in height and has a lap weight of nearly four pounds, half of which is concentrated in the display, where all the major components live. This makes the Helix noticeably top-heavy and prone to toppling backward when propped on a lap or other unstable surface. Furthermore, the Helix's hinge, which contains the mechanism for separating the device, has limited range of motion, so the screen can only be tilted back 20 degrees or so, which is fine if you plan to always use the laptop from a fixed position, but is otherwise highly annoying. There are just two USB 3.0 ports and a Mini DisplayPort on the back of the dock, where they're not easily accessed without turning the laptop. The chintzy storage allotment, consisting of a sole 128GB SSD, seems like the least of the Helix's woes.

On the positive side, the screen—an IPS panel with 1920x1080 res—looks great, with accurate color reproduction and a wide viewing angle. That's a lot of pixels to cram onto an 11.6-inch touchscreen. To help navigate some of the smaller elements, where chunky fingers might not suffice, Lenovo bundles a digitizer pen, stowed in a handy compartment built into the screen. As for the Helix's other input methods, we found the keyboard comfortable and easy to type on, despite its relatively small size, but the glass touchpad, which feels nice, was frustratingly erratic until we fiddled with the Synaptics driver.

In our benchmark tests, the Helix was a conservative performer. It has the same CPU as our zero-point Ultrabook, yet performed noticeably slower, due to the Helix's proc rarely, if ever, hitting its Turbo Boost potential—most likely in the interest of thermals. The Helix did, however, shine in battery life, outlasting other laptops of its class, with an HD video runtime of nearly five hours.

We have few complaints about the Helix as a tablet. The screen does a good job with media, the speaker is robust, and while it's not exactly light at almost two pounds, it's not uncomfortable to hold either. The wide format, however, can make it challenging for smaller hands to type with thumbs while also holding the device. And our video rundown test saw the battery last just shy of three hours. For ports, it offers USB 2.0 and Mini DisplayPort, along with a SIM card slot.

In the end, the Helix's versatility has to be of paramount importance—enough to overlook its inherent compromises. Otherwise, it's too tempting to spend the $1,650 this Helix costs on a separate laptop and tablet, each of which does its respective job without trade-offs.

–KATHERINE STEVENSON

VERDICT 7

Lenovo ThinkPad Helix

+ HELICAL Versatile; nice IPS screen; good battery life for a laptop.

− HELLACIOUS Laptop makes too many compromises; tablet battery is limited.

$1,650, www.lenovo.com

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS3 (sec)	840	1,080 (-22.2%)
Photoshop CS3 (sec)	100	110 (-9.1%)
ProShow Producer (sec)	1,122	1,417 (-20.8%)
MainConcept (sec)	1,901	2,299 (-17.3%)
Quake III (fps)	358.2	294.9 (-17.7%)
Quake 4 (fps)	76.1	54.4 (-28.5%)
Battery Life (min)	221	268

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point ultraportable is an Intel reference Ultrabook with a 1.8GHz Intel Core i5-3427U, 4GB of DDR3/1600 RAM, integrated graphics, a 240GB SSD, and Windows 8 64-bit.

SPECIFICATIONS

CPU	1.8GHz Core i5-3427U
RAM	4GB DDR3/1600 dual-channel
Display	11.6-inch 1920x1080 IPS LCD
Storage	Toshiba 128GB SSD
Ports	On dock: 2x USB 3.0, Mini DisplayPort; on tablet: USB 2.0, Mini DisplayPort, SIM card slot
Lap / Carry	Laptop: 3 lbs, 10.9 oz / 4 lbs, 3.3 oz; tablet only: 1 lb, 13.7 oz



The Helix's ThinkPad pedigree is evident: all-black body, rubberized surfaces, and the familiar black, slightly concave keys surrounding the signature red TrackPoint nubbin.



The StoreJet only comes in purple, but it's good enough that we don't mind.



The Buffalo Mini-Station Extreme is very tough and able to keep its cable stashed, too.

USB Hard Drive Hootenanny

Hard drives you can actually smack down

When it comes to your data, there are times when a USB key doesn't have the capacity or speed you need, and you can't afford to have a delicate hard drive smashing on the floor. Enter ruggedized USB 3.0 hard drives, which address all of our needs by combining speed and reliability into a supremely portable package. We put three such drives to the test, and found out which one has the speed you crave and the durability you require. –JULIAN REICHE

LACIE RUGGED MINI USB 3.0 1TB

The LaCie Rugged Mini we tested is a 1TB 5,400rpm drive that features a classic brushed-aluminum housing with USB 3.0 and LED activity indicators. The bright, removable rubber case makes this hard drive resistant to drops from four feet, which matches the Transcend StoreJet's durability. Its two-year warranty is the shortest of the three drives in our roundup, though.

LaCie's bundled software is bare-bones, and offers a power-saving utility and Genie Timeline backup software. Genie Timeline provides a simple interface with the option for a hierarchical file view, the ability to enable AES 256-bit encryption, and support for basic backups. You get just the bare minimum though, and will have to pay $40 for the Premium Edition of the software that lets you do things like schedule backups and recover files. To its credit, LaCie includes 10GB of cloud storage that's good for one year, and it's the only drive here to do so. But at $130 it's also the most expensive one here, so we were surprised by how spare the software package is given its cost.

In our file-copy benchmark tests, the Rugged Mini was the fastest of the group by a teeny, tiny margin, chewing through our 30GB file transfer test in four minutes, 47 seconds and averaging 107MB/s via its USB 3.0 interface. In our synthetic tests, the drive's read and write speeds averaged 84.3MB/s and 82.3MB/s, respectively, which were mid-pack but close enough to the other two to call it a draw.

While the Rugged Mini has the best looks in the group, it's a shame there's nowhere to hide/stash its gangly USB cable. In general, this is a stylish drive that covers the basics very well in that it's sufficiently fast, has decent software, good protection, and looks neat. But for the price, we expected more. Throw in the fact that it has the shortest warranty here and most limited software, and you have a tough sell to anyone not shopping on brand identity alone.

VERDICT 7

LaCie Rugged Mini USB 3.0 1TB

$130, www.lacie.com

TRANSCEND STOREJET 1TB 25H3P

Transcend's StoreJet 1TB sports a 5,400rpm hard drive and has the best price-per-gigabyte ratio in this roundup. It's also available in 500GB, 750GB, and 1.5TB flavors, and meets "military drop-test standards" via a three-stage protection system that includes a soft rubber shell, internal hard drive suspension chamber, and reinforced hard casing. The drive is tastefully appointed, with a patterned back and shaped edges that provide excellent grip, but unfortunately it only comes in purple. The drive is something like an iPhone in that it has just one button. Located on the top-right corner of the drive, the button serves as an activity indicator, is the means of remounting the drive after ejecting it, and can be configured to run a backup routine, as well. There is nowhere to stash the included USB 3.0 cable, so it just flops around like a ponytail.

The StoreJet 25H3p's included software suite is polished and abundant, sporting full-featured backup software, a drive formatter, and a file system converter. Dubbed "TranscendElite," the backup software has a simple interface that quickly lets you manage and schedule backups or encrypt/decrypt files. It's beginner-friendly, with a clean and intuitive interface.

On average, the USB 3.0 Transcend StoreJet slightly outpaced the other two drives in our speed tests, but again, they



The Rugged Mini can take some abuse, but also dishes some out to your wallet.

are all very close. Although the StoreJet's burst speed maxed out at 187.4MB/s, placing it behind the LaCie drive, its average read and write speeds of 85.6MB/s and 84.2MB/s put it ahead of the other two. In our drop tests, the StoreJet took several trips to the pavement and kept right on chugging along.

Overall, the Transcend is a well-rounded package. Its three-year warranty is excellent, we love the software bundle, and it's rugged and speedy, making it a very full-featured and solid choice. It's extremely affordable, too, costing just $10 more than the Buffalo but offering twice the capacity.

VERDICT 8

Transcend StoreJet 1TB 25H3p

$90, www.transcend-info.com

BUFFALO MINISTATION EXTREME 500GB HD-PZU3

The Buffalo MiniStation Extreme is extreme all right, featuring a drop rating of seven feet, five inches, which is the highest of all the drives in this roundup. It's available in both 500GB and 1TB sizes, and comes in red, silver, or black. One handy feature is the routing along the edge of the drive to hide the included USB 3.0 cable, making it the only drive in this group to offer such a convenience. Although the front of the drive features glossy plastic, the back sports a rubberized material that prevents it from sliding off your desk, which is appreciated. The integrated USB cable is pretty short, but Buffalo redeems itself by bundling a 1.5-foot extension cable. Extending the cable from its housing reveals a useful drive-activity indicator that flashes green when the drive is in use.

Buffalo's bundled utilities cover a wide range of useful tasks including creating a RAM disk, making backups, scheduling sleep mode, enabling 256-bit AES file encryption for files and folders, and auto-authenticating commonly used computers. You can also password-protect the drive and configure it to lock after a number of incorrect password attempts. The MiniStation Extreme's bundle also includes programs called TurboPC EX and DiskFormatter, which are simply not useful and have interfaces that look like they were developed in 2001.

Performance-wise, the MiniStation was consistently very close to the other drives in our tests but came in just a bit slower, which isn't a huge deal so we're not knocking it too much. It also sailed through all of our drop tests despite being dropped from twice the distance as the others.

When you add it all up, the Buffalo comes out on top in this roundup by virtue of its excellent software, extreme durability, color options, cable management, and decent speed. It's truly the best package here, just barely edging out the Transcend drive for top honors. It's a bit expensive for its capacity, but worth it.

VERDICT 9

Buffalo MiniStation Extreme 500GB HD-PZU3

$80, www.buffalo-technology.com

BENCHMARKS

	LaCie Rugged Mini USB 3.0	Transcend StoreJet 1TB 25H3p	Buffalo MiniStation Extreme 500GB HD-PZU3
Price	$130	$90	$80
Capacity (GB)	1,000	1,000	500
30 GB Folder Transfer (min:sec)	**4:47**	**4:47**	4:50
HD Tune			
Burst Rate (MB/s)	**189.4**	187.4	187.2
Avg. Read (MB/s)	84.3	**88.3**	82.9
Avg. Write (MB/s)	82.3	**84.2**	79.8

Best scores are bolded. All tests conducted on our hard-drive test bench, which consists of a Gigabyte Z77X-UP4 motherboard, Intel Core i5-3470 3.2GHz CPU, 8GB of RAM, Intel 520 series SSD, and a Cool Master 450W power supply.



When in doubt, park your zerglings—er, troops—behind concrete and let them watch you mortar the surrounding area into oblivion.

Company of Heroes 2

'Reveille' for the multiplayer; 'Taps' for the solo campaign

TO BE HONEST, we really wanted to dislike Company of Heroes 2. As is tradition whenever we have a new strategy game, we immediately fired up the game's skirmish mode and cracked open a delicious can of soda to accompany (what we assumed would be) a short march to victory.

Although we weren't playing as the Germans in this match, it sure felt that way. Specifically, German soldiers at the turn of the 1940s, whose bravado-filled failure march into Russia as part of Operation Barbarossa so greatly opened up the Eastern Front that the Russians would be a-knockin' on Berlin's door—Hell March–style—within four short years.

In other words, Germany got its ass kicked, and so did we. And thus began our descent into the steep learning curve that is Relic Entertainment's Company of Heroes 2. A zerg rush, this game is not—at least, not in its multiplayer matchups. In its single-player campaign, the game comes just shy of throwing medals at you for sending countless waves of cheap soldiers to their untimely death—an odd mechanic, given the "unit veterancy" feature that's designed to encourage soldier longevity.

The game's single-player campaign offers up a mix of its dullest and most interesting moments. A design imbalance permeates its 14 campaign missions worse than a Russian winter on a poor conscript—which isn't just a lame metaphor, it's also a game mechanic.

As was the Russian style at the time, some missions task you with simple survival: Hold a position while the Germans send countless waves of pain your way. Move to a new position. Hold that. Move to a third position. Hold that. In these instances, you'll find yourself focusing less on strategy, more on prayer (and ample use of the hotkey that tells your guys to heave-ho a grenade).

This can be fun, to an extent. Sometimes, it seems as if the game's in-mission reprieves arrive the split-second before you Ctrl+Alt+Del your frustrations away. Other times, the "survival" element transforms into a rousing game of, "How long can I watch my monitor until I get bored?" The AI seems to get a real kick out of sending battalions right into sustained mortar and rocket fire for no obvious benefit.

Relic likes to occasionally grant you an extreme amount of firepower—World War II whoop-ass, as it were. We like carnage, but it almost seemed a little unfair to pepper German bases with Howitzers and BM-13 Katyusha rocket launchers that reach an ungodly distance across the map. We'd prefer a happy medium—decent, non-frustrating challenges that you can use creative tactics to overcome, but a bit lighter on the "weapons of mass destruction"–like add-ons that can imbalance the gritty fighting.



You'll start skipping the ugly cutscenes faster than you can say "Russian winter."



Cover is your friend until a not-so-friendly grenade comes a-bouncing in.

To put it another way, Company of Heroes 2 makes you feel like a god among RTS players at times; an inept newbie at others.

Relic does try to spice things up by peppering the campaign with uniqueness, like the mission that forces you to spread your forces around campfires and (warm?) bunkers, lest they freeze to death in the cold Russian winter (Relic calls this "ColdTech;" you can even sink a vehicle by destroying the icy river it's sitting on.). There's also the fun mission-turned-puzzle where your motley band of infantry has to take on a tank all by itself. Spoiler: The tank shrugs off your wussy little bullets; you do not shrug off the tank's shells.

The game's general storyline is every bit as hard to follow as it is pointless. We dislike the overall "flashback" motif enough as is. It gets downright annoying when you realize that your mission is set in a flashback within a flashback (with nary an *Inception*-like "bahhhummm" noise to keep you awake).

We'll spend as much time praising the game's story as Relic put into its cutscenes; which is to say, barely any. These are some of the uglier movies we've seen in a modern title, almost as bad as the not-so-infrequent "AUTOSAVE" box that often accompanies in-game events within the single-player campaign.

The raw mechanics of Company of Heroes 2 are mostly unchanged from the game's predecessor: Capture points to gain a steady tick of resources, which you use to build various kinds of infantry and armored units. New to the game is an awesome line-of-site mechanism that prevents your soldiers from seeing anything that terrain blocks; unfortunately, it's still a bit tough to move grouped units behind effective cover *en masse*.

You'll be doing a lot of micromanaging if you want to maximize your army's positioning, and you'll want to hit your head into the desk when you see enemy infantry skillfully running right past the firing arc you just spent three minutes setting up for your machine gun squad. What we'd give for a unit upgrade that would allow automatic turning of the "BFG."

Don't take our frustration for displeasure; Company of Heroes 2 is a challenging strategy title, which almost adds to the game's enjoyment once you begin to master troop manipulation, rock-paper-scissors unit matchups, and general war techniques. As is often the case with sequels, if you loved the now-7-year-old Company of Heroes, you'll find much to appreciate within its follow-up.

As you unlock more upgrades within the game itself, you can better customize your commanders and special bonuses within the game's engaging Theater of War mode and multiplayer matchups—both areas we found ourselves sinking more time into than the game's single-player campaign. Achievement nuts will love the 362 different ways this game gives you to show your friends your Eisenhower cred (though we find that, and the "unlock" system, a tad excessive).

If that's not enough boasting, you can also use Company of Heroes 2's built-in support for Twitch.tv-based streaming to show your friends that you're Patton incarnate. All you have to do is type in your user name and password; the game takes care of the details (which you can tweak, if you prefer), and flicking your stream on and off is as easy as hitting a button on the top of your screen.

The single-player's no Starcraft II, and the tricky multiplayer is likely to frustrate newcomers and strategy fans at first, but there's a lot of gritty enjoyment to be had in Company of Heroes 2. Don't give up on this title if it feels tough; you'll miss out on some engaging gameplay. That, and this game will shoot you in the head if you try to run away. –**DAVID MURPHY**

VERDICT 8

Company of Heroes 2

+ ENEMY AT THE GATES Gritty, realistic visuals; thought-provoking gameplay; voluminous single-player missions; an achievement-junkie's dream.

– PEARL HARBOR Trite single-payer campaign; poor storyline; wide-ranging disparity in mission difficulties; managing multiple fighting fronts can feel overwhelming.

$60, www.companyofheroes.com ESRB: M

LAB NOTES

JULIAN REICHE **ALPHA FLIGHT INTERN**



Time to Leave Disneyland

My time at *Maximum PC* is over, and it was Kick Ass

AFTER A LONG, cold winter in Canada, I knew there would be no better way to spend my summer than an internship at the *Maximum PC* offices adjacent to Silicon Valley. Arriving during the building of Dream Machine, my gamer eyes shed a tear looking at the 4K panel and the glorious graphics those four water-cooled Titans could pump out. In my time spent alongside the seriously badass *Maximum PC* staff, I saw the hard work that's put into every issue, whether it's continuously running benchmarks while reviewing products or determinedly pushing graphics cards to their limits—they are true PC enthusiasts.

Gordon's rants are a signature part not only of the No BS Podcast but of the day-to-day office environment, and the unwritten rule seems to require all staff to dedicate 10 minutes of every hour to one of his diatribes. After two months of working with and learning from the team, I can officially give the M*aximum PC* crew a solid 10 Kick Ass award, eh!





Jimmy Thang
Online Managing Editor

Hyundai unveiled its new zombie-killing car at our Comic-Con booth this year. The machine was cool, but I'm sure I could have designed a more killer rig. I would have skipped the flamethrower (too much of a liability) and exterior sentry gun (leaves you too exposed). You can design your own zombie-killing dream machine here: http://bit.ly/18RW3UT.



Chris Zele
Ensign First Class

I recently installed Windows 8 on a PC that had multiple drives. What I didn't realize is that Windows 8 actually puts a recovery partition not only on the boot drive, but also on storage drives. After the OS was fully installed, I removed the storage drive and the PC wouldn't boot. I ended up having to reinstall Windows entirely. I wish I knew this was an issue before I installed the OS!



Josh Norem
Senior Editor

This month, I went 10 rounds with the MSI GTX N770 Lightning and ultimately threw in the towel, as the card was just too unpredictable. On the opposite end of the spectrum was the EVGA GTX 780 with ACX cooler, which is essentially perfect. Fast, quiet, Titan-esque, for less money, with killer software. It doesn't get much better than that.



Tom McNamara
Associate Editor

Cooler Master's N200, N400, and N600 cases are rolling in, and NZXT has launched its 530 and H630 full-towers. Corsair finally introduced a microATX tower, and I think we had three 900Ds floating around the office at one point. Rosewill and MSI seem to have one or two coming out every month. Soon, they will outnumber us all. Sleep with a screwdriver under your pillow.

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Tubing Diameter
> GPU Compute
> PC Supremacy

Color Me Confused

I was reading through the news story in the August 2013's issue ("AMD's Richland: Can Intel Answer?"), and something derailed my train of thought: You guys refer to AMD as "Team Green." I could have sworn that Team Green referred to Nvidia, not AMD.

—Tyler Phillips

ASSOCIATE EDITOR TOM MCNAMARA RESPONDS: AMD was the original Team Green, before Nvidia became a big player, so some of us older gearheads still refer to them as such. With their Radeon and FX branding, though, AMD is arguably more red than anything else these days. We'll have to petition Gordon for an official decree, but last time we did that, we ended up having to sacrifice an intern in his honor.

CUT, COPY, PASTE

In our review of the Toshiba Kirabook (August 2013), we incorrectly stated that it had HDMI 1.3, when it's actually version 1.0, so video output is limited to 1920x1080.

Can't We All Just Get Along?

New subscriber, love the magazine, but after six issues I've noticed a common thread in your writing that's making me crazy: AMD vs. Intel. The last thing we as PC enthusiasts need right now is infighting. AMD/Intel create fantastic competition in the marketplace and that's where it should stay, in my opinion. Seems like in any article I read (such as the August 2013 story about Haswell), you can't seem to help but take an AMD-endorsed shot at Intel users over LG1150, which nobody cares about. Everyone pretty much will divide along the lines of their "first," if you will. These two companies are keeping you in business, and keeping us building/gaming. Please, enough with the "who's better" argument. The answer is obviously neither when you're speaking in terms of 1–3fps or a differential of milliseconds.

—Ryan Pitts

DEPUTY EDITOR GORDON MAH UNG RESPONDS: First.

But seriously, I disagree. It has long been an annoyance to Intel users that the company changes sockets at the drop of a hat. For mainstream boards we've gone from LGA1156 to LGA1155 and now LGA1150 in roughly four years. I acknowledge that there are perfectly valid technical reasons for the changes, but that doesn't make it any less annoying. AM3+, meanwhile, has had a very graceful path from AM2 all the way from 2006 until now. Finally, there is more than a 1–3fps or milliseconds difference between a new Haswell processor and AMD's fastest CPU. In fact, most agree Intel has been in the driver's seat for a long, long time, with AMD a very distant speck in the rear-view mirror. Given that situation, I think even Intel would agree it can take a little joshing on occasion.

A Kink in the Tube

Quick question on water-cooling systems: In your article titled "Build It: Three Water-Cooling Techniques Detailed and Constructed," posted online 03/14/2011, it was reported that the size of tubing made a significant difference in cooling performance: "3/8-inch-diameter tubes spiked our temperatures on 100 percent CPU use to an average of 81 C and a maximum of 83.5 C. The same cooling setup using 1/2-inch tubing hit an average of 73 C with a maximum of 75.25 C. The more fluid you can move over your heat exchanger, the cooler the average temperature that fluid will be—that's why 1/2-inch tubing wins."

However, in a similar article titled, "Build a Kick-Ass Liquid-Cooling System—6 Simple Steps," posted 3/24/2010, a completely opposite stance was reported: "...The demonstrable performance difference between the two sizes of tubing is slim, and 3/8-inch tubing can bend more without kinking, so we used that for our system."

So, without sounding too sarcastic, what gives? I understand that it was a year between when the two articles were written, but I don't think the laws of physics changed in that time. I would appreciate

↘ submit your questions to: comments@maximumpc.com

some info on the subject, as I am planning on building my first water-cooling system and have grown to trust and depend on your info and reviews.

—William

ASSOCIATE EDITOR TOM MCNAMARA RESPONDS: The required diameter for tubing is a common point of contention, even among *Maximum PC* staff. The bottom line is that you use the tubes that you like the best, though we do recommend the kind without plasticizer, since that can gunk up things and get stained over time.

CUDA You Please Help Me?

Your GPU benchmarks contain a long list of games with their respective frame-rate outputs. For the video editors out there though, some benchmarks on transcoding or other GPU processing would be of great value. We used to hear so much about CUDA, but almost nothing recently. Please consider adding more on this going forward and letting your readers know if you are consciously omitting it for some reason.

—Andrew Linder

> “YOU CAN'T SEEM TO HELP BUT TAKE AN AMD-ENDORSED SHOT AT INTEL USERS OVER LG1150

SENIOR EDITOR JOSH NOREM RESPONDS: You are right, Andrew, we do exclude it. Honestly, it's been a long time since we've covered workstation software and with the renewed emphasis on compute chops with the GTX Titan and the upcoming Radeon GPUs, we should delve into it for future reviews. Stay tuned.

All Hail the PC

Shucks, how can anyone say the PC is on the way out? It's like saying the world can get along without Mack trucks. I built the *Maximum PC* Ultra build (Blueprint) last year and trying to compare an iPad, laptop, or some ridiculous four-inch-screen PDA/phone device to my Intel Core-i7 hexa-core, 16GB system with two big monitors is laughable. When I do audio mixing, my computer does the mix 700 times real-time! I'd like to see an iPad to that. When I edit or convert video, my machine uses 13GB to 15GB of RAM. There are laptops that might do that but, without the liquid cooling on the CPU and the other 12 or so fans, it would burn out like a cheap candle in a week. I laugh at the toys of humanity. When you need to do real work, get a PC.

Long live the King!

—Larry White

EDITOR-IN-CHIEF KATHERINE STEVENSON RESPONDS: You don't need to convince us, Larry! Thanks for reading.

[NOW ONLINE]

50 BEST GOOGLE STREET VIEWS

Everybody loves traveling, but flights and hotels can be costly. In addition, the weather around the world can be pretty extreme. That's why we've put together a list of the top 50 best Google Street Views so you can explore the most kick-ass places in the world from the comfort of your home monitor. Exotic locales include Antarctica, the Great Barrier Reef, and more. http://bit.ly/12EjARf.



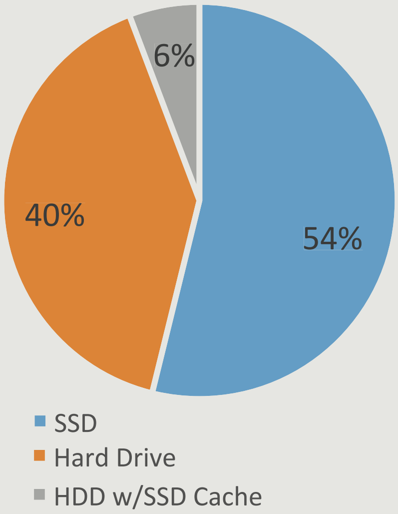
Facebook Polls

Naming Atom's Successor

This month, we reported that Intel might be retiring its beleaguered Atom branding, so we thought our readers could help Intel by offering a suitable replacement for the company's next-gen low-power, low-cost chip.

Mark Blue: Intel Plutonium
Aaron Kunsman: Nucleus
Christopher Childers: NEO
Brandon Strangfeld: Photon
Anthony Su: Core Nano
Len Viator: Corinna
Kyle Heitzenrater: Atom Bomb
Lukas Swee: Core i1
Brendan BeHanna: Core Micro
Michael Martell: Intel Clawsdesperatelyformarketshare
Mike Orcutt: Pinto
Joe Conway: Piece of Chip
Jordan Beisel: Remarket-r
David Robinson: Pentiatom
Donald Benson: The Gunganator

What Storage Device Do You Use for Your OS?



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THE BUILDS



BUDGET



BASELINE

INGREDIENTS (Budget)

PART		PRICE
Case	NZXT Source 210 Elite	$43
PSU	Thermaltake 550W SP-550PCBUS **NEW**	$45
Mobo	ECS H77H2-M3 Micro ATX	$68
CPU	Intel Core i5-3350P	$172
Cooler	Stock Intel cooler	$0
GPU	MSI Radeon HD 7790 R7790-1GD5/OC **NEW**	$126
RAM	2x4GB Crucial Ballistix Sport XT DDR3/1600 **NEW**	$55
Optical Drive	Samsung SH-224BB	$15
SSD	SanDisk Ultra Plus 64GB **NEW**	$70
HDD	Western Digital Caviar Blue 1TB	$65
OS	Windows 8 64-bit OEM	$90

Approximate Price: $749

ALTHOUGH HASWELL has arrived, bringing with it a budget Intel Core i5 (as well as the high-end stuff), we haven't gotten hands-on with a budget-appropriate motherboard, so our entry-level system will remain Ivy Bridge for now. We are bumping the system RAM up from 4GB to 8GB, however, since we found a good deal on some Crucial sticks. This will give the rig some more breathing room for multitasking. To make room in the budget, we dropped the modular power supply and went with a 550W "Smart" unit from Thermaltake. We've used the 630W version around the office and it's been great. We also saved some cash by switching from Asus to MSI's Radeon HD 7790 card. We spent a little extra to upgrade the SanDisk SSD to the Ultra Plus for a bit more speed.

INGREDIENTS (Baseline)

PART		PRICE
Case	Corsair Carbide 200R	$50
PSU	Corsair CX500M 500W	$55
Mobo	Gigabyte GA-Z87-UD3H	$160
CPU	Intel Core i5-4670K	$225
Cooler	Cooler Master Hyper 212 Evo	$32
GPU	Sapphire Radeon HD 795011196-19-20G	$264
RAM	8GB Corsair Vengeance DDR3/1600	$60
Optical Drive	Samsung SH-224BB	$15
SSD	Samsung 840 Evo 120GB **NEW**	$110
HDD	Seagate Barracuda 1TB	$70
OS	Windows 8 64-bit OEM	$90

Approximate Price: $1,131

WE ARE AWARE that this build is a bit pricey for a "baseline" budget, but we're performance junkies. An unlocked Intel Core-i5 CPU, beefy Gigabyte motherboard, and muscular video card are just par for the course. The Radeon HD 7950 is a bit long in the tooth, but its low price and high performance combine with AMD's "Never Settle: Reloaded" game bundle to make it one hell of a compelling video card. AMD's FX-8350 CPU, however, isn't as consistently speedy as the Core i5-4670K. The SSD ecosystem continues to evolve at a steady clip, with Samsung producing the 840 Evo line just as we were going to print. It's super-fast right out of the box, sports fancy DRAM caching tech, and it smokes the SanDisk Extreme that we had in here last month.

PERFORMANCE



COMPARED TO THE Baseline config, our Performance build adds 10 Benjamins to the sticker price and nets us a full-tower case, Intel X79 motherboard, 850-watt power supply, fully roided GPU, water cooling, and bigger and faster storage. We could have gone with a Haswell-based system, but we prefer leaving ourselves extra bandwidth on the PCI Express bus for multiple video cards (which is also why the PSU gets a 350-watt bump). Speaking of which, nothing from AMD comes close to the Nvidia GTX 780, which gets within spitting distance of a GTX Titan after some overclocking. EVGA's "ACX" dual-fan cooling system will also keep temps and noise under control. The Samsung 840 Evo SSD takes over from the 840 Pro this month, though, as its combo of raw speed, caching features, and price are the best we've seen yet. The Pro will be getting the caching software in the future, at which point it may overtake the Evo. But for now, the new guy is king. The NZXT 530 updates the 630 with better aesthetics and cable management.

INGREDIENTS

PART		PRICE
Case	NZXT Phantom 530 **NEW**	$130
PSU	Corsair HX850	$130
Mobo	Asus Sabertooth X79	$325
CPU	Intel Core i7-3820	$290
Cooler	NZXT Kraken X40	$95
GPU	EVGA GeForce GTX 780 ACX	$660
RAM	4x4GB Corsair Vengeance DDR3/1600	$120
Optical Drive	Asus BW-12B1ST	$60
SSD	Samsung 840 Evo 250GB **NEW**	$190
HDD	Seagate Barracuda 3TB	$135
OS	Windows 8 64-bit OEM	$90

Approximate Price: $2,225

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best.

UPGRADE OF THE MONTH
SAMSUNG 840 EVO 1TB



We thought that high-end solid-state drives were hitting the ceiling of the SATA 6Gb/s bus, but the Samsung 840 Evo sidesteps that by using system DRAM and SLC NAND emulation to cache frequently accessed data. This allows it to cross the 1GB/s threshold in benchmarks, which is awesome. It's expensive, but it'll burn off your eyebrows. $650, www.samsung.com

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